

HMH SCIENCE **DIMENSIONS**TM

ENGINEERED *for the* **NEXT GENERATION**

Effective NGSS Instruction

GRADES 6–8

Your Guide to the 5Es and
Three-Dimensional Learning



Print & Digital Curriculum

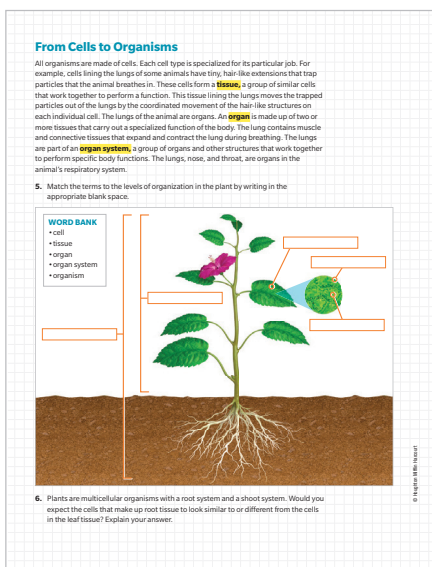
HMH Science Dimensions™ provides the richest NGSS-based 3D learning experiences available. Whether you choose print, digital, or a combination approach, students will be ready to succeed at the **Performance Expectations**.

BOTH PATHS OFFER

- Parallel Lesson Content
- Hands-on Investigations
- 5E Learning Model
- Math & ELA Connections
- Evidence Notebooking
- Engineering Activities
- Collaborative Learning
- Assessment
- Unit Performance Task
- Three-Dimensional Learning

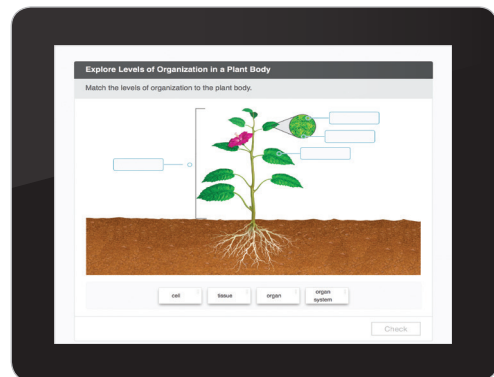
PRINT PATH

At K–8, engage students with a write-in worktext that requires them to take ownership of their learning.



DIGITAL PATH

The robust interactive online Student Edition contains all the content from the print books, enhanced with high-interest interactive elements!



Digital? Print? It's Your Choice!

Because both the digital and print paths include the same content, your learners can follow *any* path to the Performance Expectations that you designate. Leverage digital for small-group work, flipped classrooms, learning centers, and 1:1 technology situations.



Whether you use the print book or the online interactive Student Edition, your students will encounter plenty of opportunities for **science and engineering practices, small-group work, and collaborative projects!**

HMH Science Dimensions

Designed—not aligned—for NGSS!

HMH Science Dimensions™ was built for you from the ground up to authentically and effectively address both the spirit and the letter of the Next Generation Science Standards (NGSS)*.

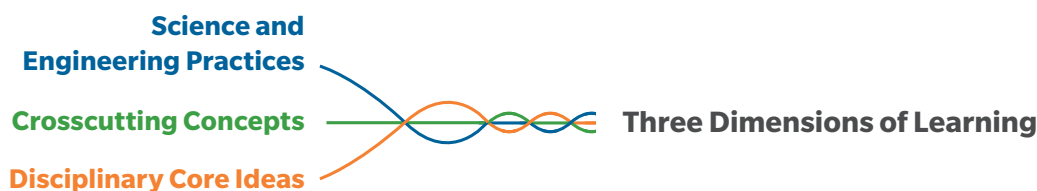
The Digital Advantage

HMH Science Dimensions incorporates highly motivating interactive digital elements, like animations, videos, simulations, and more. This approach allows the program to harness the power of technology, so that students are more engaged, resulting in a more effective learning experience. Throughout this walkthrough, note the **▼ DIGITAL ADVANTAGE** sections highlighting the interactive elements designed to optimize learning.

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Three-Dimensional Learning

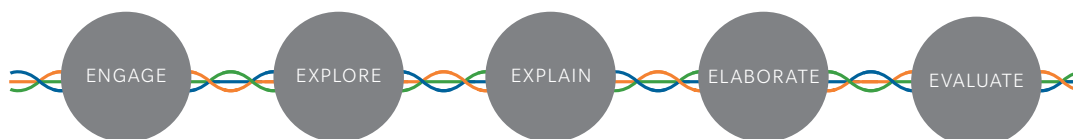
Any curriculum based on the NGSS must integrate the **Science and Engineering Practices**, **Crosscutting Concepts**, and **Disciplinary Core Ideas** (the Three Dimensions of Learning) throughout all lessons. *HMH Science Dimensions* intertwines the Three Dimensions into a cohesive, braided approach that ensures students will increase science proficiency.



Lesson Structure—the 5E Model

HMH Science Dimensions consists of units containing closely related lessons.

Each lesson is built around the familiar **5E instructional model**, endorsed by NGSS thought leaders. We've overlaid the **Claims/Evidence/Reasoning** learning model below with the 5Es to give you a better understanding of how a pedagogy driven by NGSS aligns to the 5Es.



ENGAGE **Stimulated to engage** with a discrepant phenomenon or puzzling question, students begin each lesson by making connections to the real world around them.

► **CLAIMS** Students hypothesize a model or explanation to the puzzle or problem presented. By evaluating their own mental models, students are prepared to study the phenomenon.

EXPLORE **Inspired to explore** new concepts and gather evidence, they learn actively through a variety of activities and resources.

► **EVIDENCE** Students perform experiments and pursue several methods of scientific inquiry to gather data and explore their model.

EXPLAIN **Challenged to explain** and test their ideas and claims, students become skilled at reasoning about how well their evidence supports their claims.

► **REASONING** Armed with real data related to the initial phenomenon or problem, students draw conclusions and adjust models.

ELABORATE **Motivated to extend** their new learning, students apply this knowledge in different situations to deepen understanding.

EVALUATE **Enabled to evaluate** how their understanding has changed, students are supported by a progression of formative and summative activities during the lesson.

ENGAGE

Every lesson starts with an Engage opportunity that asks: **Can You Explain It?** or **Can You Solve It?** The Engage section involves a **phenomenon to explain**, a **problem to solve**, or a **discrepant event** to spark students' curiosity.

As students state **claims**, they begin to analyze their assumptions and ideas, preparing for the learning experiences that follow.

Module K: Forces,
Motion & Fields

Go online to view the digital version of the Hands-On Lab for this lesson and to download additional lab resources.

CAN YOU EXPLAIN IT?
How might this island have appeared overnight?

Japan, an island formed virtually overnight. The view here is of a volcanic eruption. By the next morning, the new island continued to grow for about two years.

suggest for how an island could suddenly appear? Or, might there be something special about the island?

Illustrate your explanation.

As you explore the lesson, gather evidence to help it suddenly appear.

Lesson 3 Earth's Plates 47

Why do these rings seem to float without touching one another instead of falling?

If you were to drop one of these rings into a gap, you would normally expect it to fall and hit another ring. Instead, when the rings get near one another, they are pushed back up, leaving them floating.

Explore ONLINE!

1. Normally objects are not able to float. What must be occurring for these rings to float instead of fall?

2. What type of force might be affecting the motion of these rings?

EVIDENCE NOTEBOOK As you explore the lesson, gather evidence to help explain the behavior of the rings.

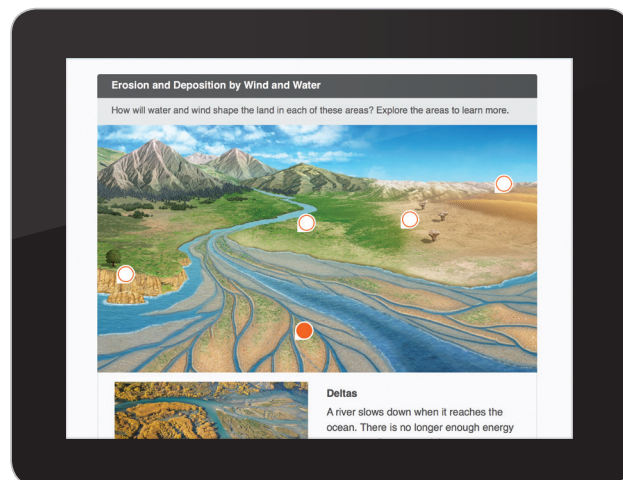
Lesson 1 Magnetic Forces 97

Module F: Geologic
Processes & History

▼ DIGITAL ADVANTAGE

Interactive Illustrations

The interactive nature of online illustrations maximizes student engagement. **HMH Science Dimensions** encourages learners to interact with images online. The digital delivery platform also allows students to collect evidence and **save it all online**. Students are also able to share their work with their teacher.



Module F:
Geologic Processes & History

EXPLORE & EXPLAIN

In the next phases of the 5E model, a series of related Explore & Explain activities are organized as **Explorations**. During these activities, learners embark on a discovery process of gathering **evidence** to either support or challenge their **claims** through:

- activities
- data analysis
- interactive illustrations
- videos
- instructional animations

Throughout the lesson, students are prompted to record their evidence using **Evidence Notebooks** where appropriate.

Student-directed formative assessments embedded in the lesson help students assess the evidence they gather. They also share their evidence with peers and collaborate on the activities.

EXPLORATION 1

Analyzing Continental Data

Continental Observations

Long ago, people noticed that some continents, such as Africa and South America, looked as if they could fit together. Explorers also discovered rocks and landforms of the same ages and compositions on different continents. They also found fossils of the same plants and animals across continents. What could explain these findings?

Fossil Data

This map shows where four types of fossils have been discovered on different continents.

3. **Discuss** Observe the shapes and locations of the continents. Do you think they have always been in the same locations, or do they move? Explain your thinking.

EXPLORATION 2

Analyzing Animal Body System Interactions

Animal Body Systems Interact to Perform Functions

Animals need to find and eat food, they need to move, and they need to respond to their environment. They may also need to maintain stable internal conditions, such as temperature. Individual body systems perform these functions, but not in isolation. Almost everything an animal needs to remain healthy requires its body systems to work together. For example, many systems work together with the digestive system to provide nutrients for cells. The nervous system sends signals to muscles in the digestive organs to contract and relax to help break up food and move it through the digestive system. Blood then carries the digested food particles from the digestive system to all the cells in the body.

The parrot fish lives on and near coral reefs. These fish got their common name from a jaw structure that looks like a parrot beak. The fish use the hard structures that make up the beak to scrape algae from coral reefs.

Fill in the table below.

Systems

nd a powerful parrot-like beak. It might. Describe how you think catch and eat food. What sensory

Module F: Geologic Processes & History

▼ DIGITAL ADVANTAGE

Rich Media

The audio and motion aspects of multimedia help learners visualize and see the Three Dimensions of Learning in action. Adding motion and context helps learners **relate to and internalize** the concepts portrayed.

Formation of a Sand Bar

Explore the animation modeling sand bar formation.

As sand erodes from a beach, it can be deposited into sand bars.

Module F: Geologic Processes & History Animation

EXPLORE & EXPLAIN

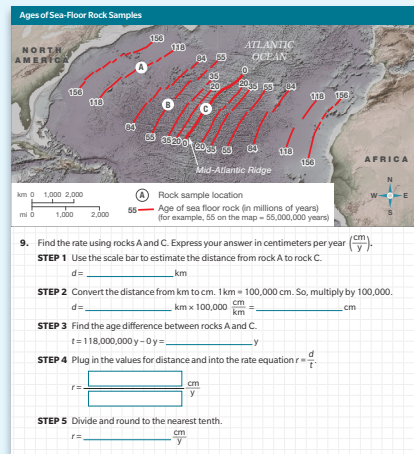
Language SmArts & Do the Math

Being science literate requires a strong foundation in English language arts and math. So **HMH Science Dimensions** includes strong connections to these disciplines. These features, called **Language SmArts** and **Do the Math**, offer activities that are **integral to the core objectives** of the lesson.



Do the Math Calculate the Rate of Sea-Floor Spreading

How fast does the Atlantic Ocean grow? To find out, we can calculate the rate of sea-floor spreading. The map shows the age of the ocean floor and three rock samples. For example, rock B is 55 million years old. So is any rock on the red line labeled "55." Rock C formed 55 million years ago at the ridge, then traveled to its current location. Rock C is now at the ridge. To find the rate of spreading, first estimate the distance between rocks B and C by using the scale bar. Divide that by the difference in their ages. In other words, rate is distance divided by time (age difference): $r = \frac{d}{t}$. So, $r = \frac{200,000,000 \text{ cm}}{55,000,000 \text{ y}}$, or about $3.6 \frac{\text{cm}}{\text{y}}$.



54 Unit 1 The Dynamic Earth

Module F:

Geologic Processes & History



Language SmArts

Use Observations to Develop an Argument

13. This plant has shallow roots, short stems, and leaves that are covered in fuzzy hairs. In what type of environmental conditions might this plant live? Use your observations as evidence to support your argument.



72 Unit 2 Organisms as Systems

Module B:

Cells & Heredity

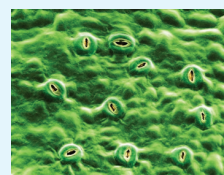


Do the Math Calculate Stomata Density

The density of stomata on a leaf surface can be calculated using the equation:

$$\text{Stomatal density} = \frac{S}{S + E} \times 100$$

where S = the number of stomata and E = the number of epidermis cells, which form the outer layer of a leaf.



Look at the photo of the leaf.

15. Count and write the number of open stomata that you can see. _____
16. If the number of epidermis cells is 150, what is the density of stomata in this area of the leaf?
17. Stomata density on a particular plant can change depending on environmental conditions. What environmental factors might influence the density of stomata? Explain your thinking.

EXPLORE & EXPLAIN

Hands-On Investigations

Hands-On Investigations are one way of addressing the **Science and Engineering Practices** of NGSS*. **HMH Science Dimensions** offers plenty of **Hands-On Investigations** that encourage students to **gather their own evidence**.

Module F: Geologic Processes & History

Hands-On Lab

Analyzing the Magnetic Force

Part 1: Distance and the Magnetic Force

You will investigate the relationship between distance and the strength of the magnetic force using a magnet and a compass. The needle of a compass is magnetic and points north due to Earth's magnetic field. If the attractive force between the compass needle and a magnet is strong enough, the compass will move.

Magnets affects the strength of the magnetic force. As magnets are moved closer together, the magnetic force increases. As magnets are moved further apart, the magnetic force decreases.

MATERIALS

- bar magnet
- compass
- tape
- tape measure or ruler

Record the distance between the edge of the bar magnet and the edge of the compass. Record the direction in degrees that the compass needle points. Repeat the experiment for different distances between the magnet and the compass. Record the data in your notebook.

What changes can a volcanic eruption cause? You will use maps to analyze the visible changes to the Mount St. Helens area that were caused by a powerful eruption. The eruption of Mount St. Helens, a volcanic mountain in the Cascade Range located in the state of Washington, is an example of a rapid change that caused large-scale changes to Earth's surface.

The volcano had been dormant since 1857, but on the morning of May 18, 1980, a massive earthquake (5.1 on the Richter scale) caused its north side to collapse. An avalanche of rock fell onto the land below. Then gases that had been under pressure inside the mountain shot out sideways, killing 500 km of surrounding forest. Ash rose thousands of feet into the air, and pyroclastic flows streamed down its sides. After nine hours, the eruption was over, but Earth's surface in the area was forever changed.

MATERIALS

- colored pencils

This satellite image of Mount St. Helens was taken after the eruption in 1980.

Procedure and Analysis

STEP 1 In this activity you are provided with information about Mount St. Helens and two maps of the area. One map is from the time between 1970 and 1980, before the eruption. The other map is from 1980, after the eruption.

STEP 2 Compare the two maps. Look for differences between them. What changed in the area around Mount St. Helens after the eruption?

Before 1980

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Hands-On Lab

Analyze Visual Evidence

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Module K: Forces, Motion & Fields

EXPLORE & EXPLAIN

Engineer It!

Engineering in **HMH Science Dimensions** goes far beyond just the engineering standards provided by NGSS. Nearly every lesson includes an **Engineer It!** feature. In each one, learners practice **thinking like engineers** and often engage in the Engineering Design Process.

Module K: Forces, Motion & Fields

Engineer It

Compare Natural and Designed Systems

Humans use an industrial process to digest plant matter for use in products, such as paper. The papermaking process begins by feeding wood chips cut from trees into a tall, cylindrical tower that has multiple cooking chambers. The cooking process uses chemicals, heat, and pressure to break down the fibers in the wood to make a material called pulp. After passing through all the cooking chambers, the pulp is sent to a washer to wash away the cooking liquid. The pulp is spread out on a screen where it is bleached and dried. The pulp is then cut, stacked, and ready for processing into paper.

21. What need does the plant digester fill? How does this compare to the need that an animal's digestive system fills?

22. Make a diagram that shows the steps of making paper into pulp. How do you think this process compares to the digestion of food by animals?

This pulp slurry will eventually be made into paper for newsprint.

Engineer It

Engineer Solutions Using Fields

Investigations of fields help astronomers understand how fields work and help engineers develop interesting new materials. Some of these materials may even be used to treat diseases.

Scientists and engineers are investigating how to use ferrofluids to deliver medication directly where it is needed in the body. This procedure could be important for cancer treatments. Doctors use drugs to kill cancer tumors, but these drugs can also kill healthy cells because delivering the treatment to only the cancer cells is not easy to do.

20. When the magnetic field is removed, the ferrofluid becomes **liquid / toxic**.

21. One potential advantage of using a ferrofluid to deliver medicine is that it **can be directed to tumors by a magnetic field / is cheaper than existing treatments**.

Ferrofluids are a mixture of tiny magnetic particles and a liquid. Ferrofluids look and act like other liquids, unless they are in a strong magnetic field. When exposed to a magnetic field, the ferrofluid forms spikes that look and act like solids.

Module B: Cells & Heredity

ELABORATE

Take It Further

To promote interest in science and prepare students for college and careers in engineering and science, we've added a **Take It Further** feature to EVERY lesson. These features **relate science to students' own lives and futures**, inspiring their interest in STEM.

TAKE IT FURTHER

Continue Your Exploration



A student touches a highly charged Van de Graaff generator. Charge moves between the student and the generator, causing the student to become charged.

- What causes your hair to stand up when you touch the sphere of a Van de Graaff generator?
 - gravity
 - buoyancy
 - electric discharge
 - static electricity
- The sphere of the Van de Graaff generator builds up positive charge on its surface. If you touch the sphere, you will gain *positive/negative/no* charges.
- Your hair strands have *positive/negative/no* charges on them when you are touching the generator. Since your hair strands are *attracted/repelled* by one another due to the electric force, they are *similarly/oppositely* charged.
- Collaborate** Together with a partner, discuss your understanding of Van de Graaff generators. Consider how the charges in objects would behave if the objects touched a Van de Graaff generator.

126 Unit 2: Electric and Magnetic Forces

TAKE IT FURTHER

Continue Your Exploration

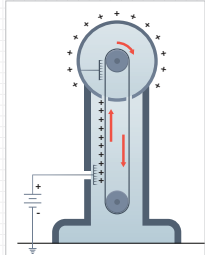
Name: _____ Date: _____

Check out the path below or go online to choose one of the other paths shown.

- Hands-On Labs
- Experimenting with the Charges of Materials
- Propose Your Own Path

Go online to choose one of these other paths.

Generators are used to demonstrate static electricity. Static electricity of charge. Negative charge builds up when an object gains more electrons than positive charges. Positive charge builds up when an object loses more electrons than negative charges. These extra charges are referred to as static charges.

When the Van de Graaff generator is turned on, a belt moves. The Van de Graaff generator removes negative electric charges from the moving belt, giving the belt a positive charge. Negative charges from the sphere are then attracted to the belt, leaving the sphere with a positive charge.

Module K: Forces, Motion & Fields

DIGITAL ADVANTAGE

Student's Choice: Take It Further

Digital delivery allows for more student choice than in print. Nowhere is this more evident than the **Take It Further** (Elaborate) portion of the lesson. Online, students have **several options to choose from**, one of which is sure to capture their interest.

TAKE IT FURTHER

- Migration
- Hands-On Labs
- Sensory Organ Adaptations
- Propose Your Own Path

Migration

Animals travel long distances in response to seasonal weather changes and changes in the availability of food. This type of travel is called *migration*. Migration is a seasonal movement from one place to another. Birds, mammals, reptiles, fish, and even insects migrate. Migration is often related to food or reproductive needs.

Migratory Behaviors

Explore the images to learn more about the some animals' migration patterns.

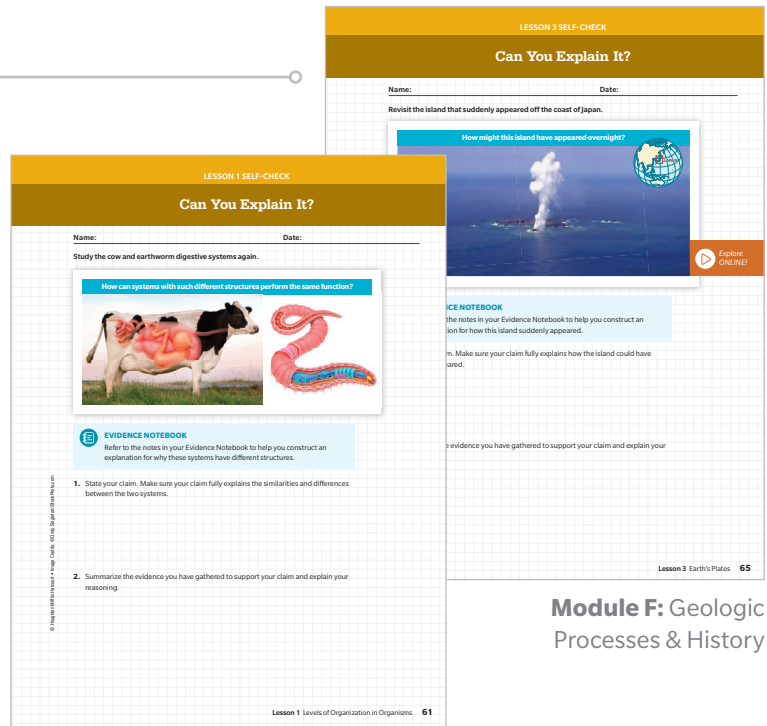


Module B: Cells & Heredity

EVALUATE

Lesson Self-Check

All the students' learning experiences come together in the Evaluate section. Students revisit the puzzling occurrence or intriguing problem they made a claim about in the Engage section. When they reach Evaluate, students return to their **claim** and evaluate the **evidence** they gathered throughout the lesson. They **reason** how the evidence supports or challenges their claim, thereby strengthening their understanding of the science.



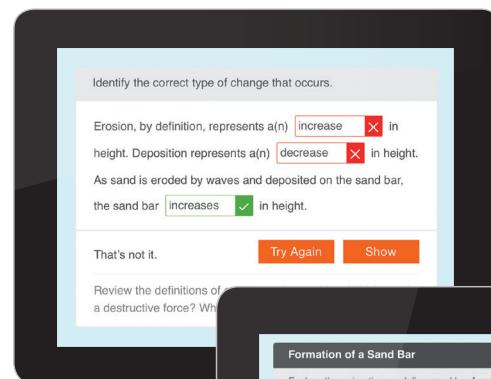
Module F: Geologic Processes & History

Module B: Cells & Heredity

DIGITAL ADVANTAGE

Assessment with Instant Feedback

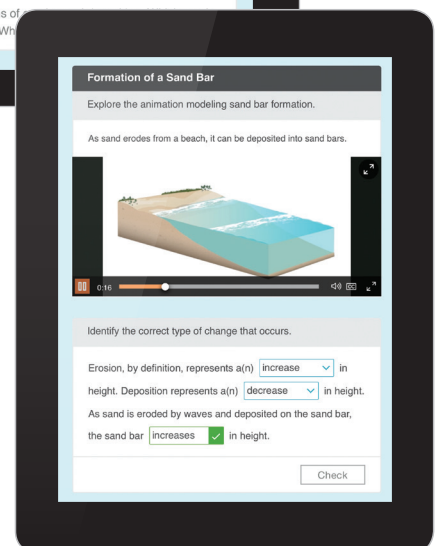
Online delivery of assessments can provide **instant feedback**. This allows learners to truly take charge of their learning by monitoring their progress while actively engaging with the lesson.



Module F: Geologic Processes & History

Scaffolded Assessment

Online learning allows scaffolded formative assessment. By responding to questions with limited-response options, students gradually increase their understanding of concepts. In these examples, students are given a choice of answers or an example of a possible answer.



EVALUATE

Formative Assessment

Lesson Formative Assessment

The interactive nature of the lessons provides constant formative assessment, but additional formative assessment is provided in the **Self-Check** at the end of each lesson. As is true throughout the program's lessons, the assessment **fully integrates all three dimensions** of science learning—Crosscutting Concepts, Disciplinary Core Ideas, and Science and Engineering Practices.

Unit Formative Assessment

At the end of each Unit, learners have access to the **Unit Review**. This formative assessment covers the same three dimensions of learning for the entire Unit.

LESSON 3 SELF-CHECK

Checkpoints

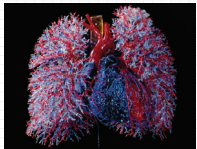
Answer the following questions to check your understanding of the lesson.

Use the photo below to answer Questions 3 and 4.

3. Which two systems are represented in this model?

- circulatory and respiratory
- nervous and circulatory
- excretory and respiratory
- nervous and digestive

4. Blood travels through the circulatory/excretory system to the lungs/kidneys where it interacts with the digestive/respiratory system to exchange gases.



The blood vessels, heart, and lungs were filled with a plastic polymer to make this cast.

5 and 6. Which system is responsible for the motion of the cheetah?



The cheetah is using its digestive/muscular system to move. It and cheetah are using their nervous systems to take in information and respond to it. Nervous systems are to cells in all parts of their bodies. Their respiratory systems are taking oxygen and carbon dioxide.

UNIT 2 REVIEW

Name: _____ Date: _____

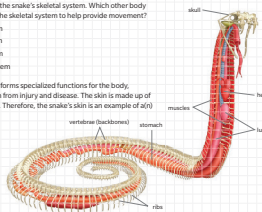
Use the diagram of the snake to answer Questions 1-2.

1. The diagram shows the snake's skeletal system. Which other body system works with the skeletal system to help provide movement?

- Digestive system
- Muscular system
- Excretory system
- Respiratory system

2. The snake's skin performs specialized functions for the body, including protection from injury and disease. The skin is made up of several tissue types. Therefore, the snake's skin is an example of a(n) _____.

- tissue
- organ
- organ system
- body structure

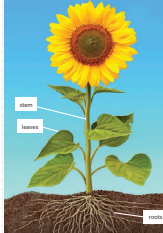


Use the diagram to answer Questions 3-4.

3. An animal's skeletal system performs the function of load production/support/transport, just as the root/shoot system of the sunflower does for that plant.

4. Which of these plant body functions requires interaction between the root and shoot system?

- getting water to all parts of the plant
- anchoring the plant to the ground
- collecting energy from sunlight
- moving nutrients throughout the plant



5. The Venus flytrap is a plant that has hairs on its leaves, which sense movement. These hairs are an example of chemical/electromagnetic/mechanical sensory receptors.

Unit 2 Organisms as Systems 115

Module B: Cells & Heredity

Summative Assessment

Each Unit includes a **Unit Project** and a separate **Performance Task** so students can demonstrate the **NGSS* Performance Expectation** competency using the **Claims/Evidence/Reasoning** approach they practiced using in the lessons.

The authentic and practical application of student learning creates a full three-dimensional science learning experience, addressing Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

Many performance-based activities are designed around STEM applications and the Engineering Design Process.

UNIT 2 PERFORMANCE TASK

Name: _____ Date: _____

What is the best design for a maglev train?

Have you ever seen a floating train? Trains that use magnetic levitation (maglev) are suspended above the track, which greatly reduces friction from the rails and allows the trains to travel between 250 and 300 miles per hour! Magnetic levitation uses attractive and repulsive magnetic forces to suspend and control the speeds and motion of the trains. Using your knowledge of electromagnets, design a maglev train that can move forward and backward. Follow the steps below to help you through the engineering design process.



The steps below will help guide your research and develop your recommendation.

Engineer It

1. **Define the Problem** Write a statement defining the problem you have been asked to solve. What are the criteria and constraints involved in designing a maglev train?

Unit 2 Electric and Magnetic Forces 173

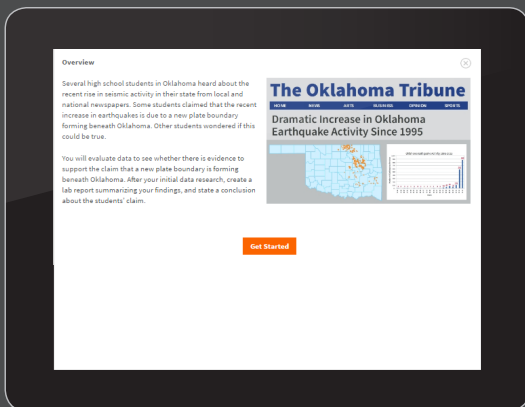
Module K: Forces, Motion & Fields

Unique Digital Simulations Reinforce Three-Dimensional Learning and Claims/Evidence/Reasoning

▼ DIGITAL ADVANTAGE

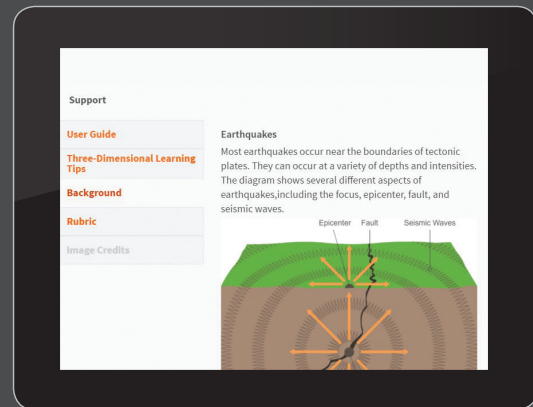
You Solve It! Open-ended Simulations

You Solve It! simulations involve a rich data-gathering or problem-solving exploration that goes far beyond requiring merely a single right answer. Available as part of the digital path, these unparalleled NGSS-centric open-ended simulations support the **Claims/Evidence/Reasoning** instructional model and allow students to answer questions and solve problems in their own way.



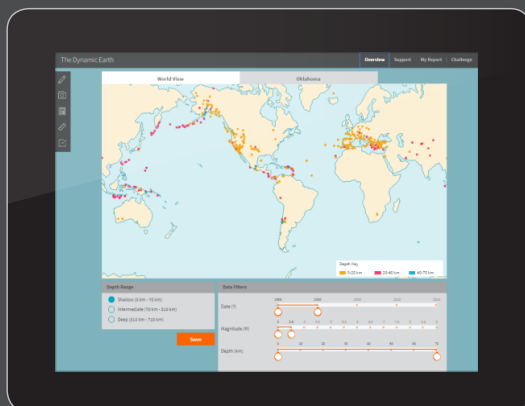
Overview

This provides context and some basic instructions on using the open-ended simulation.



Support

The Support section reminds students of the NGSS connections, such as relevant SEPs, DCIs, and CCCs.



Simulation

This open-ended simulation gives students FULL control. They make their own choices on how to gather evidence or achieve a solution.

Notes/Report

Students can jot notes about their evidence and reasoning for later creating a report about their claim. They can restart their work at home or on the go when they log into their online Student Edition with any compatible device.

The Teacher Edition—Your NGSS Companion

The Teacher Edition is designed to easily guide you through an NGSS* lesson organized around the 5E model.

LESSON 1

Weathering, Erosion, and Deposition

Building to the Performance Expectations

The learning experiences in this lesson prepare students for mastery of

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.

[Trace Tool to the NGSS](#)
Go online to view the complete coverage of the standards across lessons, units, and modules.

SEP Science & Engineering Practices

Constructing Explanations and Designing Solutions
Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe nature operate today as they did in the past and will continue to do so in the future. (MS-ESS2-2)

VIDEO Constructing Scientific Explanations

Developing and Using Models
Develop and use a model to describe phenomena. (MS-ESS2-1), (MS-ESS2-4)

VIDEO Developing and Using Models

DCI Disciplinary Core Ideas

ESS2.A Earth's Materials and Systems
All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)

VIDEO Earth's Energy Budget

ESS2.A Earth's Materials and Systems
The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)

ESS2.C The Roles of Water in Earth's Surface Processes
Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)

CCC Crosscutting Concepts

Scale, Proportion, and Quantity
Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS2-2)

VIDEO Scale, Proportion, and Quantity

Stability and Change
Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1)

VIDEO Stability and Change

CONNECTION TO MATH

MP.2 Reason abstractly and quantitatively.

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

CONNECTION TO ENGLISH LANGUAGE ARTS

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.

SL.8.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

4A Unit 1 The Dynamic Earth

3D Learning Objectives

Using the program's customized 3D Learning Objective and clearly labeled Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices, educators can keep track of the specific standards that students are covering at any given point in the lesson.

LESSON 3 Engage • Explore/Explain • Elaborate • Evaluate

EXPLORATION 2 Analyzing Oceanic Data

3D Learning Objective

In this lesson, students will gather evidence from ocean floor data and analyze this data to find patterns and construct an explanation of how the Earth's ocean floor has changed over time. By completing a calculation of the rate of sea-floor spreading, students will understand how the history of Earth shows that tectonic processes continually generate new ocean floor at ridges and destroy old sea floor at trenches.

SEP Analyze and Interpret Data
Students will analyze and interpret oceanic data to develop an understanding of the changes in the Earth's ocean floor.

Connection to Physical Science
Sonar Technology | Hydrographer A person who maps and studies the sea floor is called a hydrographer. These scientists use sound to "look" at the ocean floor. Scientists use multibeam and side scan sonar to map the ocean floor. Multibeam sonar measures the depth of the sea floor by analyzing the time it takes for sound waves to travel from a ship to the sea floor and back. Side scan sonar makes an image of the sea floor by analyzing the strength of a return echo over a short period of time.

Differentiate Instruction
Extension Provide early finishers with a map of the continents. Students should research the Mid-Atlantic Ridge and label it on their map. Students can then debate what role the plate boundaries played in the formation of the Mid-Atlantic Ridge.

EXPLORATION 2 Analyzing Oceanic Data

Discoveries in the Ocean

In the mid-1950s, new technology allowed scientists to map the ocean floor. They found a global system of oceanic ridges that they called the mid-ocean ridge. One view, the Mid-Atlantic Ridge, runs along the middle of the Atlantic Ocean. Scientists also found deep ocean trenches, which are the deepest valleys on Earth's surface.

How Deep Is the Ocean?
The deepest part of the ocean is the Mariana Trench, which is 11,033 meters deep. The deepest part of the ocean is the Mariana Trench, which is 11,033 meters deep. The deepest part of the ocean is the Mariana Trench, which is 11,033 meters deep.

52 Unit 1 The Dynamic Earth

LESSON 1 Engage • Explore/Explain • Elaborate • Evaluate

EXPLORATION 3 Modeling Weathering, Erosion, and Deposition

3D Learning Objective

Students will solidify their understanding of how processes such as weathering, erosion, and deposition shape the Earth's surface. They observe time and space phenomena at various scales by developing and using models that represent various landforms. They use the information obtained from these models to construct explanations about how agents such as water, wind, and gravity change the land over time.

CCC Scale, Proportion, and Quantity
Students will observe evidence of events at a large time scale to understand how an historic flood happened.

Engineer It
Identify Solutions Students consider which technologies made it possible to understand the catastrophic changes that occurred as a result of the failure of the glacial dam blocking Lake Missoula. Ask them to think about the evidence that shows how the natural dam failed and which technology would best analyze that evidence.

Answers
19. Sample Answers: The development of new technologies such as satellite imagery provide a visual of the spatial scale of change by tracking the visual evidence of water flow from Lake Missoula. The development of carbon dating technology provides the ability to take soil and rock samples from various locations and relate them to a time or place, as a result of the flood.

20. Engineer It What technology is used in the engineering of the space age machine?
It is possible for us to understand the scale of changes that occurred as a result of the flooding of the glacial dam blocking Lake Missoula by using a large variety of tools.

EXPLORATION 3 Modeling Weathering, Erosion, and Deposition

Modeling Weathering, Erosion, and Deposition

You can use a model to study a problem. Just as you can use models to investigate the processes of weathering, erosion, and deposition, computer simulations can also be used to study how they work. You can use a model to study how they work. You can use a model to study how they work.

Modeling a Historic Flood
The Missoula Flood was part of a historic event that took place over 10,000 years ago. These floods were the result of a glacial dam blocking Lake Missoula. The floods were the result of a glacial dam blocking Lake Missoula. The floods were the result of a glacial dam blocking Lake Missoula.

14 Unit 1 The Dynamic Earth

3D Learning Objective

Students will solidify their understanding of how processes such as **weathering, erosion, and deposition shape the Earth's surface**. They observe time and space phenomena at various scales by **developing and using models** that represent various landforms. They use the information obtained from these models to construct explanations about **how agents such as water, wind, and gravity** change the land over time.

3D Item Analysis

The 3D Item Analysis in the Unit Review identifies the associated Three Dimensions of Learning for EACH review question. This helps educators assess students' knowledge of each component of the Next Generation Science Standards.

3D Item Analysis	5	6	7	8	9
SEP Constructing Explanations & Designing Solutions					•
SEP Developing and Using Models		•		•	
SEP Analyzing and Interpreting Data	•				
DCI ESS1.C The History of Planet Earth	•			•	
DCI ESS2.A Earth's Materials and Systems	•		•		•
DCI ESS2.C The Roles of Water in Earth's Surface Processes	•				
CCC Patterns	•	•			•
CCC Stability and Change	•			•	
CCC Energy and Matter	•		•		

Engage in Argument from Evidence
Have students write the different types of plate movement by creating a graphic organizer that identifies the movement and the geological formation commonly associated with this movement.

Differentiate Instruction
RTIExtra Support For students, have them describe in turn what the diagram shows. Have each student explain what the arrows depict and describe the meaning of Mid-Atlantic Ridge.

Answers
6. The mid-ocean ridge is located where two plates are moving apart. The ocean grows wider as the continents move.
7. The size plate motion causes the ocean between the continents to get larger. The ocean can't change its size.
8. Iceland is located along the ridge as regions to rise to the surface because the island which provides heat to warm the underground water that feeds the springs.
9. These events do not have frequent volcanic and earthquakes because they are not located at plate boundaries.

3D Item Analysis

	5	6	7	8	9
SEP Constructing Explanations & Designing Solutions					•
SEP Developing and Using Models		•		•	
SEP Analyzing and Interpreting Data	•				
DCI ESS1.C The History of Planet Earth	•			•	
DCI ESS2.A Earth's Materials and Systems	•		•		•
DCI ESS2.C The Roles of Water in Earth's Surface Processes	•				
CCC Patterns	•	•			•
CCC Stability and Change	•			•	
CCC Energy and Matter	•		•		

Unit 1 The Dynamic Earth 89

Common Core State Standards

For added convenience, many of the Math and ELA features in the lessons identify the Common Core State Standards that are referenced by NGSS.



Do the Math

Calculate the Rate of Sea-Floor Spreading

MP.2 Reason abstractly and quantitatively

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem.

Students will use a rate equation to calculate the rate of sea-floor spreading. **Answer: 2 km per hour.**

FORMATIVE ASSESSMENT



Language SmArts

Cite Evidence for Plate Tectonics

RST.6-8.1 Cite Evidence

Developing Theories Discuss with students the importance of theories. The theory of plate tectonics may be considered the most important theory in geology because it unifies and explains so much about other topics, including the formation of geological features, the processes that cause earthquakes and volcanoes, the rock cycle, Earth's past climates, sea-floor spreading, fossil and rock distribution, and more. Without the theory of plate tectonics, it is hard to understand how these topics relate to each other.

FORMATIVE ASSESSMENT
Language SmArts
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24. Sample answer: Placing continents together, seems to show that fossil and mountain locations fit together. Measurements of continental shelves also support this. The locations of mid-ocean ridges and trenches, and the process of sea-floor spreading, show that oceans grow between continents. GPS instruments measure plate speeds and directions.

Unit 1 The Dynamic Earth

LESSON 3 Engage • Explore • Explain • Evaluate
EXPLORATION • Exploring Plate Motion, continued

Scale, Proportion, and Quantity
Students will use a model to reinforce their understanding that plate tectonics move over a very long time scale.

Collaboration
Claims, Evidence, and Reasoning Plate motion can be challenging to comprehend because it is not easily observable. Ask students to compare the movement of tectonic plates to other processes that happen slowly, but that they have seen because they can see the result, such as grass growing.

Answers
23. From left to right, plates move toward each other; plates move away from each other; plates move toward each other.

FORMATIVE ASSESSMENT
Language SmArts
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Unit 1 The Dynamic Earth

Do the Math
Calculate the Rate of Sea-Floor Spreading
MP.2 Reason abstractly and quantitatively
6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem.

Students will use a rate equation to calculate the rate of sea-floor spreading. **Answer: 2 km per hour.**

Differentiate Instruction
RTIExtra Support If students have trouble understanding this equation, ask them how fast they would be going if they walked 2 kilometers in 1 hour. **Answer:** 2 km per hour. In this example, the rate is "2 km per hour," which can also be written as the ratio. And the whole equation would be $\frac{2 \text{ km}}{1 \text{ hour}} = \frac{2 \text{ km}}{1 \text{ hour}}$

For students still having difficulty, try discussing the meaning of the word rate. Note to students that rate describes how much time it takes to complete an action.

Collaboration
Group Activity Together with a partner, determine the rate of sea-floor spreading of the remaining rock samples in the Do the Math example that are 150, 84, 35, and 20 million years old. Report the answer in centimeters, and compare these answers to the answer for Rock A shown in the diagram.

Answers
A. **STEP 1:** 3000 cm **STEP 2:** 3000 cm **STEP 3:** 300,000,000 cm **STEP 4:** 300,000,000 cm **STEP 5:** 118,000,000 years **STEP 6:** 2.5 cm/yr

54 Unit 1 The Dynamic Earth

Do the Math
Calculate the Rate of Sea-Floor Spreading

How fast does the Atlantic Ocean grow? To find out, we can calculate the rate of sea-floor spreading. To do this, we need to know the distance that rock A has moved, and how long it has been moving. The distance that rock A has moved is 3000 cm. The time that it has been moving is 118,000,000 years. We can use the equation $\text{Rate} = \frac{\text{Distance}}{\text{Time}}$ to find the rate of sea-floor spreading. The rate is $\frac{3000 \text{ cm}}{118,000,000 \text{ years}}$, which is about 2.5 cm/yr.

Now calculate the rate of sea-floor spreading for the other rock samples.

STEP 1 Find the distance that rock B has moved. $\text{Distance} = 3000 \text{ cm}$

STEP 2 Find the time that rock B has been moving. $\text{Time} = 118,000,000 \text{ years}$

STEP 3 Use the equation $\text{Rate} = \frac{\text{Distance}}{\text{Time}}$ to find the rate of sea-floor spreading. $\text{Rate} = \frac{3000 \text{ cm}}{118,000,000 \text{ years}}$

STEP 4 Find the rate of sea-floor spreading. $\text{Rate} = 2.5 \text{ cm/yr}$

STEP 5 Find the distance that rock C has moved. $\text{Distance} = 3000 \text{ cm}$

STEP 6 Find the time that rock C has been moving. $\text{Time} = 118,000,000 \text{ years}$

STEP 7 Use the equation $\text{Rate} = \frac{\text{Distance}}{\text{Time}}$ to find the rate of sea-floor spreading. $\text{Rate} = \frac{3000 \text{ cm}}{118,000,000 \text{ years}}$

STEP 8 Find the rate of sea-floor spreading. $\text{Rate} = 2.5 \text{ cm/yr}$

STEP 9 Find the distance that rock D has moved. $\text{Distance} = 3000 \text{ cm}$

STEP 10 Find the time that rock D has been moving. $\text{Time} = 118,000,000 \text{ years}$

STEP 11 Use the equation $\text{Rate} = \frac{\text{Distance}}{\text{Time}}$ to find the rate of sea-floor spreading. $\text{Rate} = \frac{3000 \text{ cm}}{118,000,000 \text{ years}}$

STEP 12 Find the rate of sea-floor spreading. $\text{Rate} = 2.5 \text{ cm/yr}$

Find more support in the online Math Handbook.

Unit 1 The Dynamic Earth

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