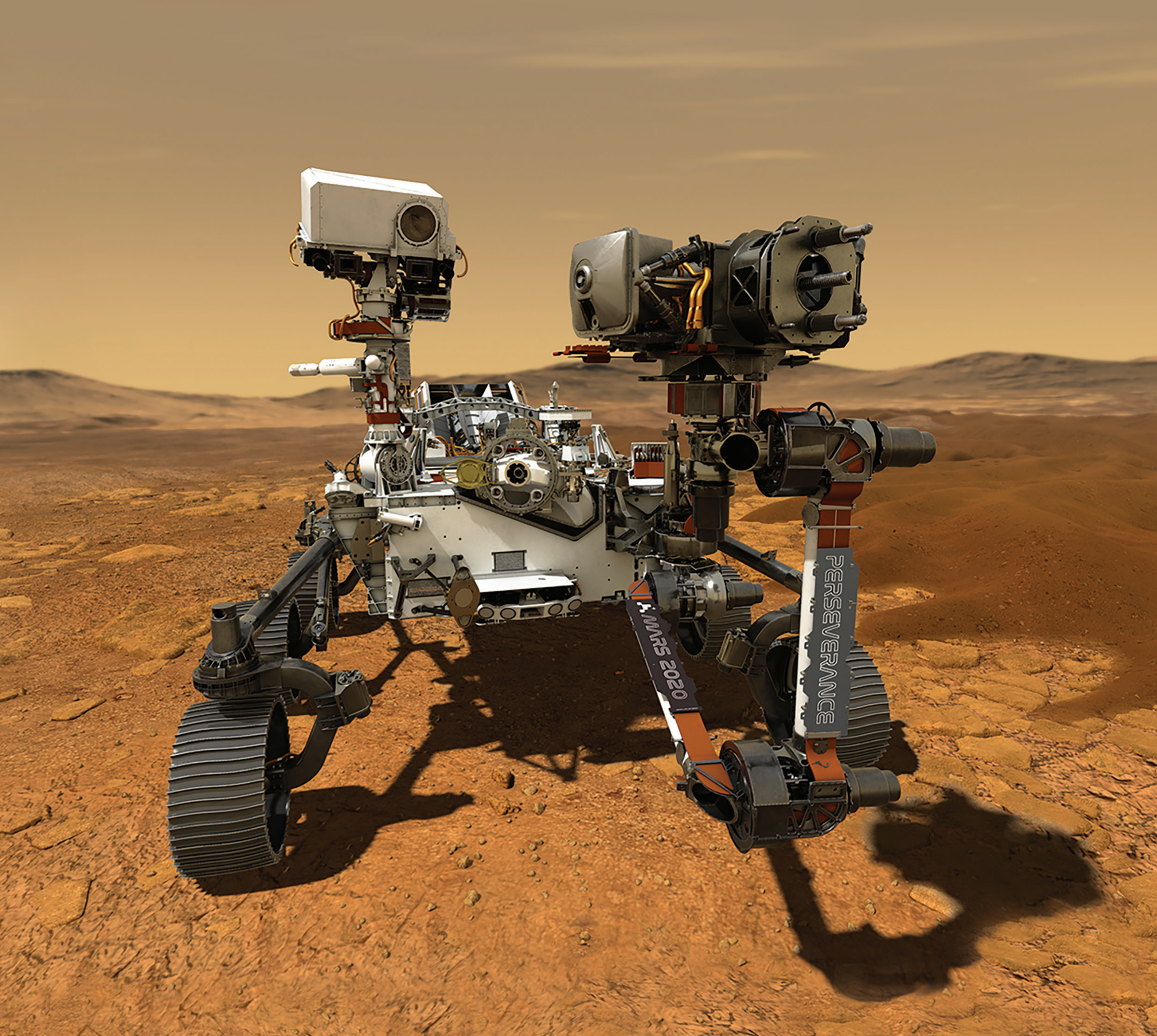
CLASSROOM GUIDE

EARTH & SPACE SCIENCES

FOR NGSS



Contents

CLASSROOM GUIDE

STUDENT EDITION

APPENDIX

ISBN 978-1-99-101400-9

Second Edition 2022

Published by BIOZONE International Ltd

Purchases of this book may be made direct from the publisher:

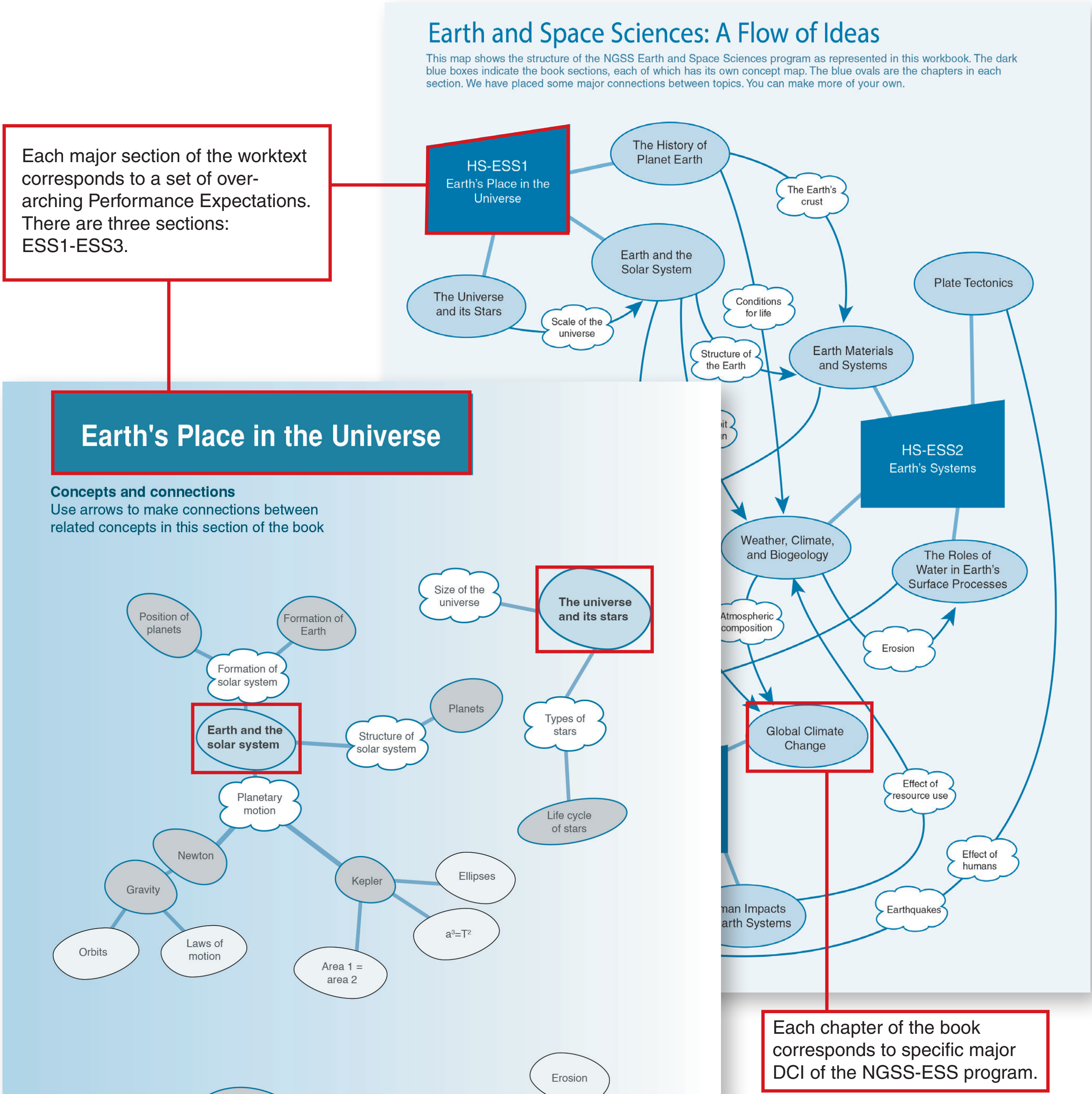
BIOZONE

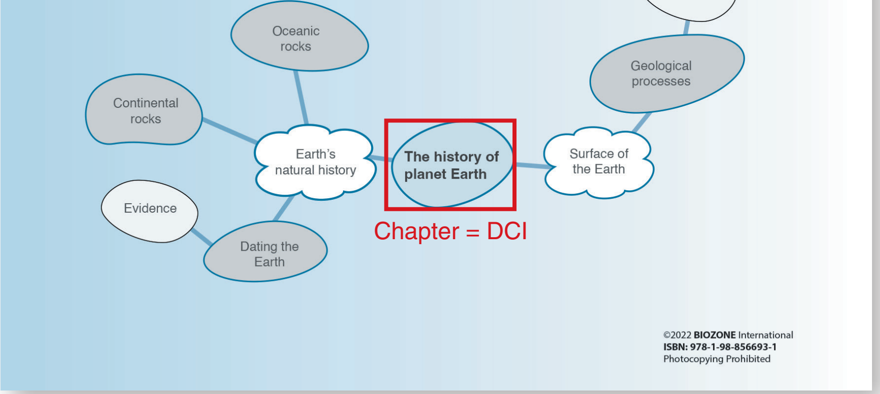
BIOZONE Corporation
USA and Canada
FREE phone: 1-855-246-4555
FREE fax: 1-855-935-3555
Email: sales@biozone.com
Web: www.biozone.com/us

FAQs
ABOUT EARTH AND SPACE SCIENCES FOR NGSS

The Concept Maps

The concept maps in *Earth and Space Sciences for NGSS* have two broad purposes: to provide a map of ideas covered in the program and to provide a vehicle for students to make their own connections between those ideas. They are particularly useful as graphic organizers for striving students and visual learners. The introductory map provides an overview of the structure of the *NGSS Earth and Space Sciences* program. Section concept maps divide the book into three parts, each providing a visual summary of one of three broad areas within the program, corresponding to ESS1-ESS3. Encourage students to draw their own connections between ideas on the concept maps as they work through the topics. This will help students to see their interrelatedness, and realize that they are not isolated, but connect with many other topics within the program.





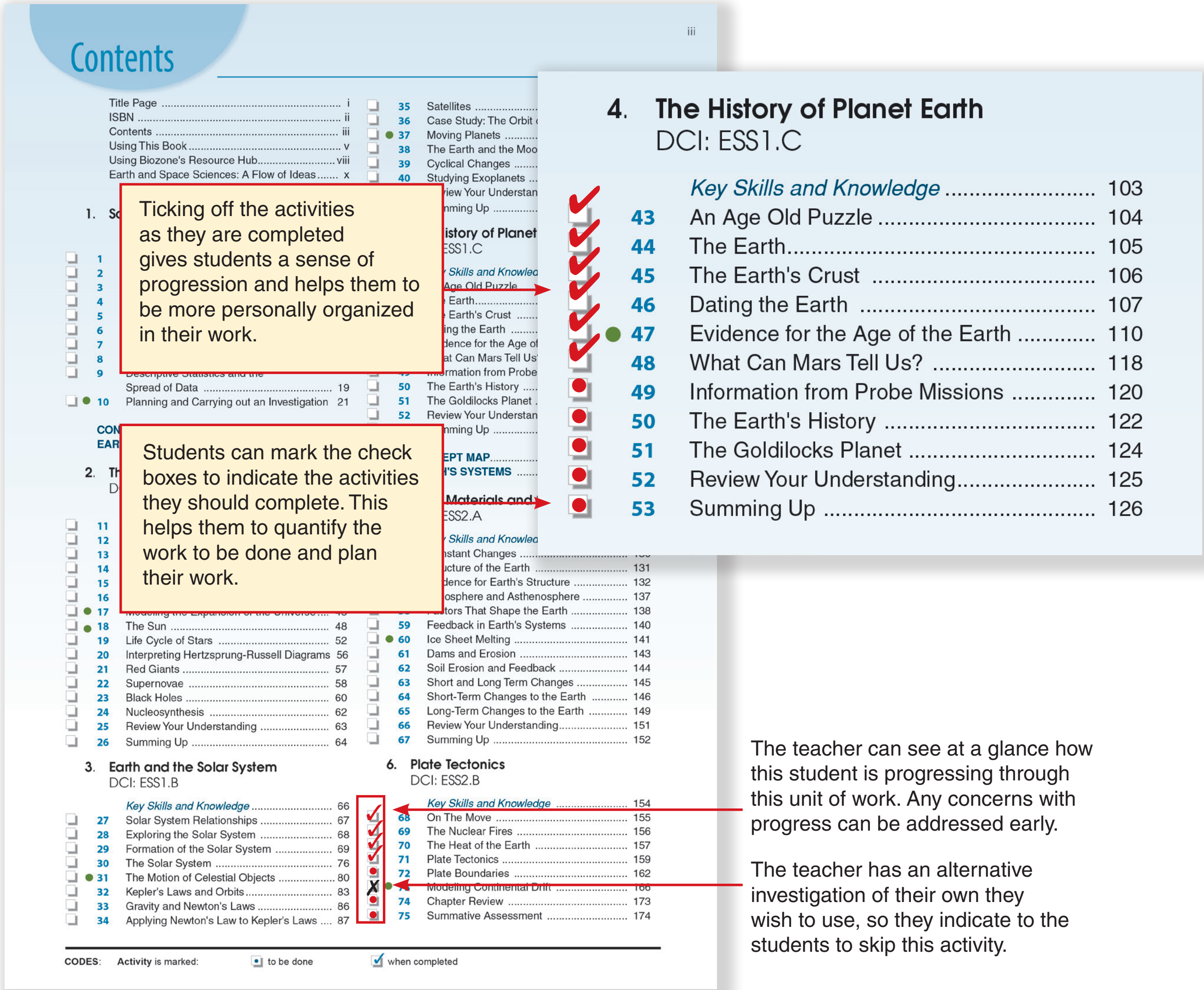
There is one concept map for the entire program (above) and one for each major collection of DCIs within a section (left).

Content coverage indicated in hierarchical order: chapter heading (blue ovals), main concepts (clouds), and related concepts (gray ovals).

Encourage your students to make their own connections between topics and annotate the map with their own ideas.

The Contents: A Planning Tool

The contents pages are not merely a list of the activities in the student edition. Encourage your students to use them as a planning tool for their program of work. Students can identify the activities they are to complete and then tick them off when completed. The teacher can also see at a glance how quickly the student is progressing through the assigned material.



Pacing Guide

A pacing guide is available for teachers to download from the Resource Hub.

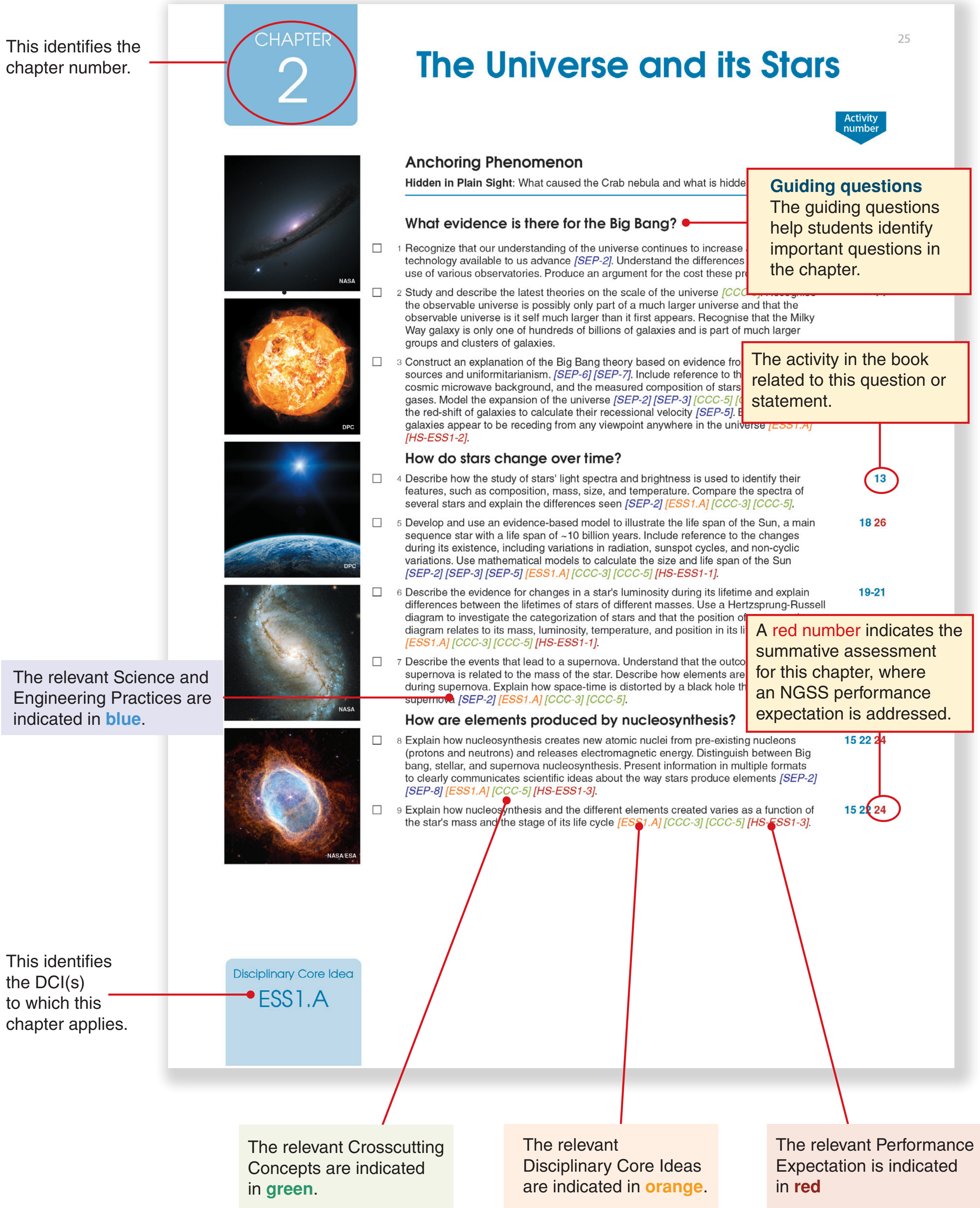
The 9-12 NGSS framework is fluid in terms of the grade in which each program is offered, so in many respects defies a rigid pacing guide. Within grade, other variables contribute to changes in pacing:

- There are opportunities for students to spend longer on some activities, e.g. in improving or refining their design solutions or in exploring simulations beyond the minimum. These elaborations will demand more time.
- The time allocated for investigations will depend on (1) how you choose to organize the class, which may be determined by available resources and (2) how far students take the investigation. Adjust your lesson plan to incorporate more or less material as needed. You may have investigations you already like to use, so you could choose to leave out equivalent investigations in the book. To help you, activities including a practical investigation are identified with a green dot (●) in the contents of the student worktext.
- For spreadsheet modeling activities, completed models are available on **BIOZONE's Resource Hub**. If you need to save time, students can use these spreadsheets instead of taking time to construct them.
- The pace may quicken as students complete more of the book and become more familiar with the style and information flow. Students gain increasing levels of competence and learn valuable skills that enable them to arrive at solutions more quickly.
- Depending on the ability of your students, you may need to use the Science Practices chapter more often to help develop math and science practice skills. Have students carry out the activities as homework if you are short on time.

Identifying Learning Intentions and Goals

In developing *Earth and Space Sciences for NGSS*, we have embraced the three dimensions of the NGSS framework, emphasizing the application of ideas and skills to new scenarios. The activities in *Earth and Space Sciences for NGSS* have been specifically designed to address the **Disciplinary Core Ideas** (DCIs)**, Science and Engineering Practices** (SEPs), **and Crosscutting Concepts** (CCCs) in a way that helps students to meet specific **Performance Expectations** (PEs).

In the Teacher's Edition, all three dimensions are embedded in the chapter introduction and color coded for easy identification (below). The Performance Expectations are also identified. It is important to note that *this coding is a tool for the teacher and is not present in the Student Edition*.



Scaffolded Learning with the 5 Es

In developing *Earth and Space Sciences for NGSS*, we have utilized the **5Es Instructional Model** as a basis for scaffolding and developing material. This approach allows students to develop a deeper understanding of content as they work through a series of related activities. By successfully completing the activities, students can demonstrate competence in all three dimensions of the framework. This is central to meeting the Performance Expectations for *Earth and Space Sciences for NGSS* with confidence.

The Five Es

Engage:	make connections between past and present learning experiences.
Explore:	become actively involved in the activity.
Explain:	communicate the learning experience.
Elaborate:	expand on the concepts learned.
Evaluate:	assess understanding of the concepts.

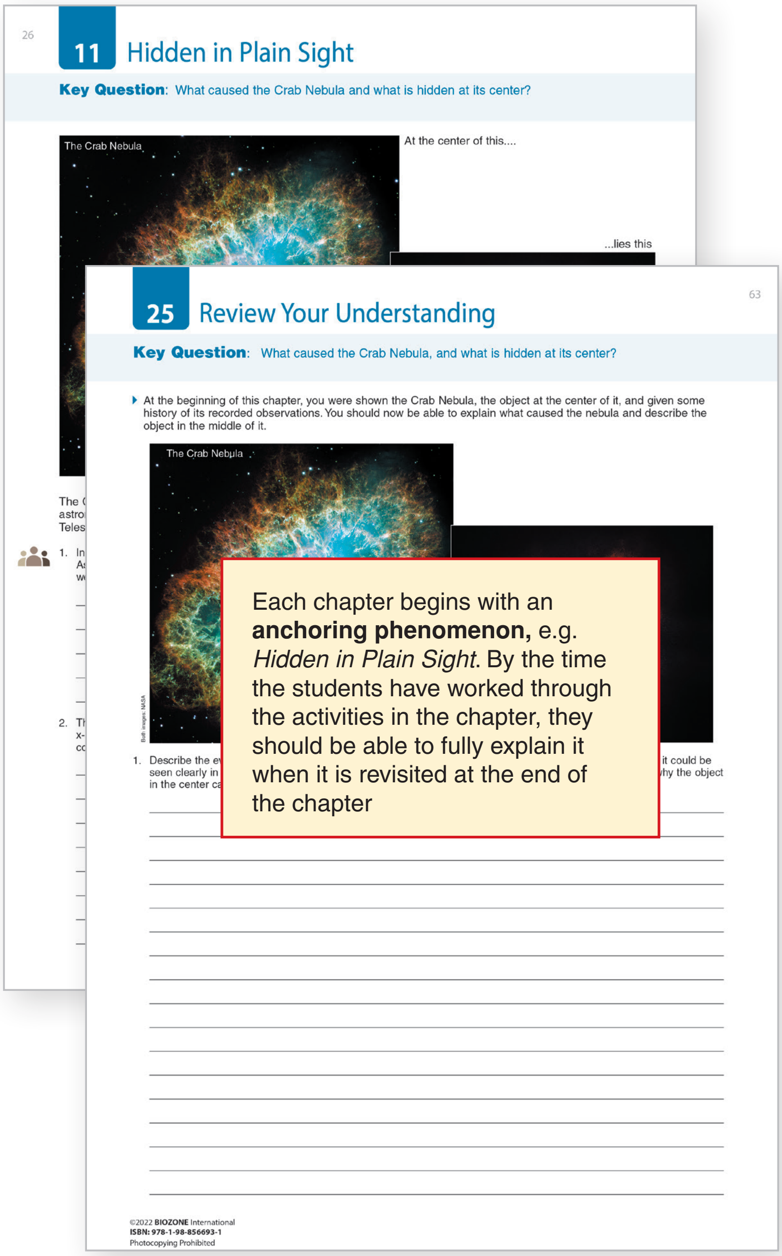
BIOZONE encourages the development of the NGSS learner profile using the 5Es instructional model

BIOZONE's NGSS series is **phenomenon-based**. Students engage with phenomena through their own investigations and observations, through modeling and data analysis, and through collaborative work and discussion.

Using phenomena to drive inquiry promotes discussion and the sharing of ideas. The scaffolded approach presents opportunities to look at phenomena from several different perspectives. This allows students of all abilities to expand their thinking and comprehension, increasing understanding as they progress through the program.

Each chapter begins with an **anchoring phenomenon** (right). In each instance, we have chosen a phenomenon that the student may be familiar with, but which they cannot explain (or cannot explain fully). Teachers can use this activity as formative assessment to find out what the students already know (or think they know) before delving into the content more fully. Teachers can also identify any gaps or misconceptions as they work through the material.

The subsequent activities in a chapter take the students, step by step, through phenomena that explore the ideas inherent in the anchoring phenomenon. By the time students revisit the anchoring phenomenon at the end of the chapter, they should be able to fully explain it.

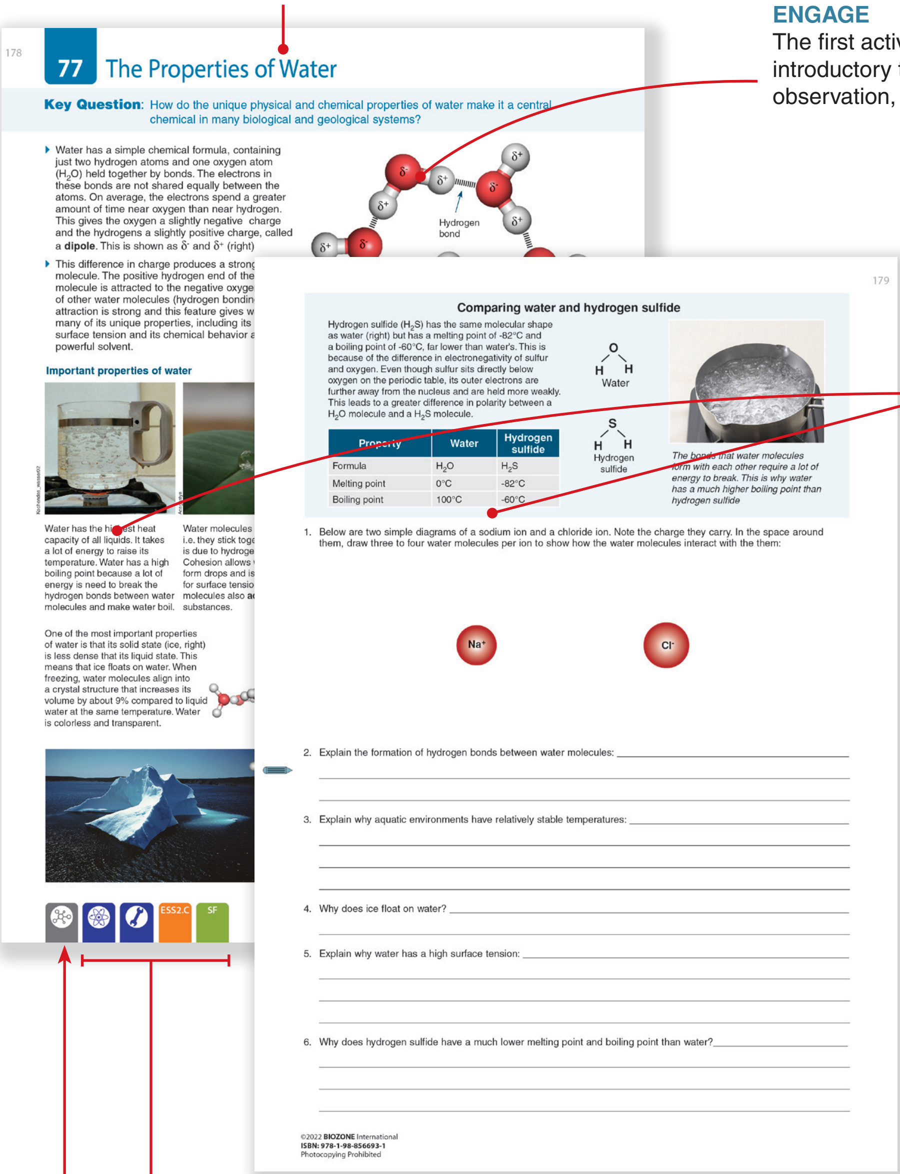


The content of *Earth and Space Sciences for NGSS* is organized into 12 chapters, based on the DCIs of the High School Earth and Space Sciences framework. Chapter 1 addresses basic skills for students in Earth and Space Sciences. Chapters 2 - 12 address the content of the framework proper. Each chapter begins with an introduction outlining learning goals, and is immediately followed by the anchoring phenomenon. Activities make up the bulk of each chapter, with each one focusing on the student investigating and developing understanding of a phenomenon, applying that understanding to new scenarios, and developing or honing a skill or science practice, e.g. graphing, data analysis, modeling, or evidence-based explanation.

Annotated diagrams and photographs are a major part of most activities, and the student's understanding of the information is evaluated through questions and/or tasks involving data handling and interpretation. Tabs at the bottom of the page identify Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts, as appropriate. Resource Hub tabs indicate if the activity is supported via **BIOZONE's Resource Hub**, which provides online teacher and student support for specific aspects of the activity.

Concepts are presented as a logical sequence, which may be divided among several consecutive activities. Understanding is developed progressively through exploration and explanation.

ENGAGE
The first activity in a related sequence is often an introductory type activity. It may begin with a brief task, observation, or example to engage student thinking.



Students are given enough information to complete the activity's questions or tasks.

Information to answer the questions is often on the page, but students may need to analyze data or information and draw conclusions to answer the questions. Sometimes, students are asked to carry out their own research or investigation.

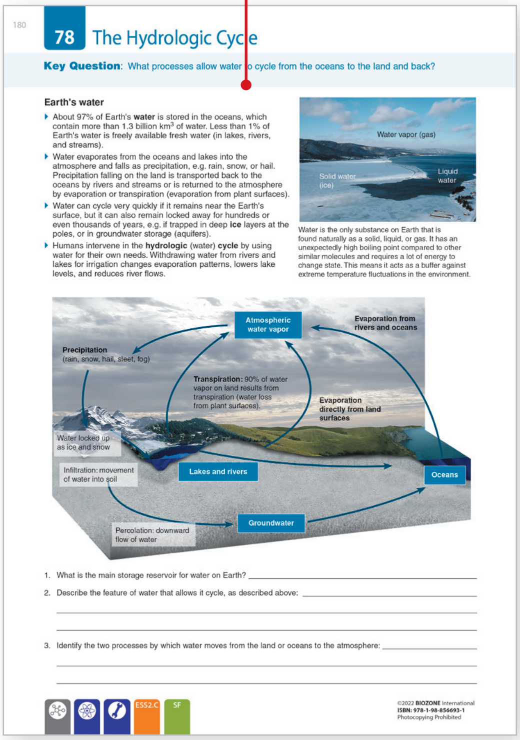
Questions allow students to demonstrate their understanding. By inputting their answers directly to the worktext, students form a record of work, allowing for easy revision in context with the stimulus information.

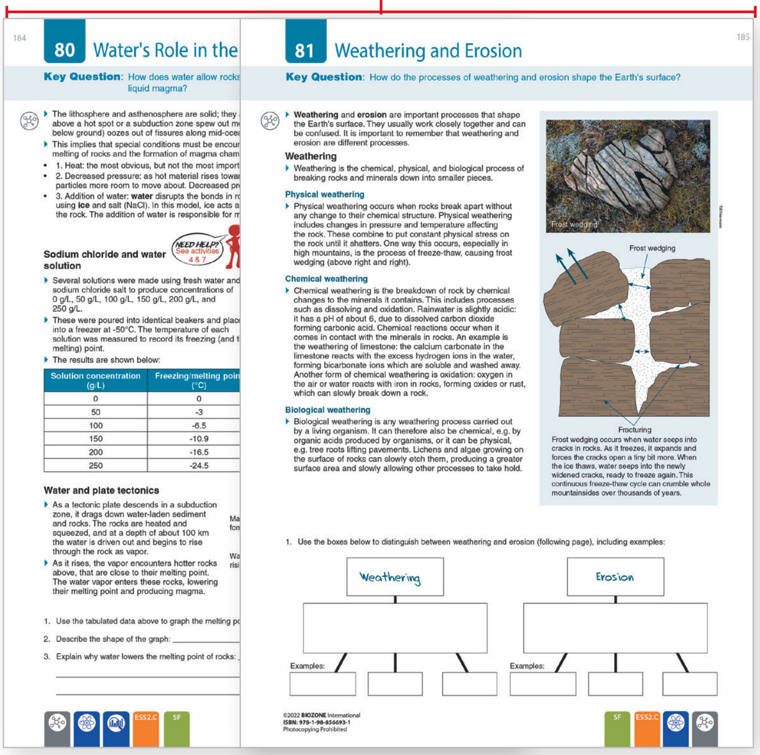
Relevant SEPs, DCIs, and CCCs are identified through the tab system.

This activity also has supporting resources on **BIOZONE's Resource Hub** assigned to it.

After being introduced to the properties of water, students now begin to **EXPLORE** the movement and cycling of water by looking at the hydrologic (water) cycle.

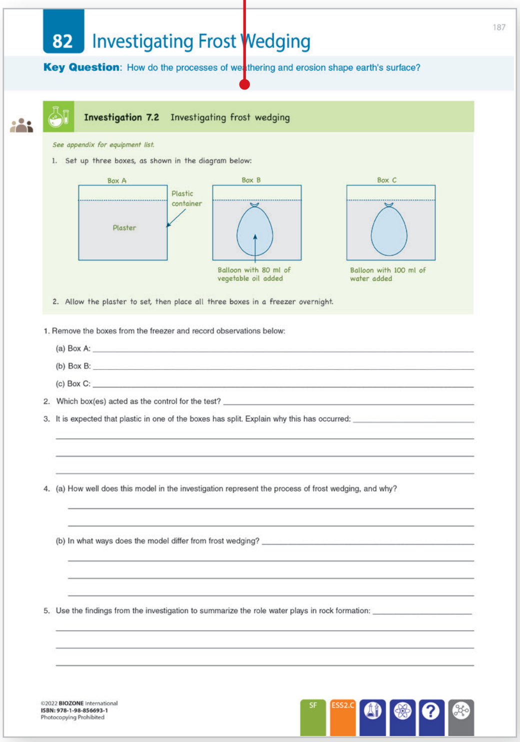
Next, students are introduced to the role water plays in altering the Earth's surface. They can use knowledge about water's properties to **EXPLAIN** how water can melt rocks and cause erosion, thus changing the appearance of the Earth's surface.

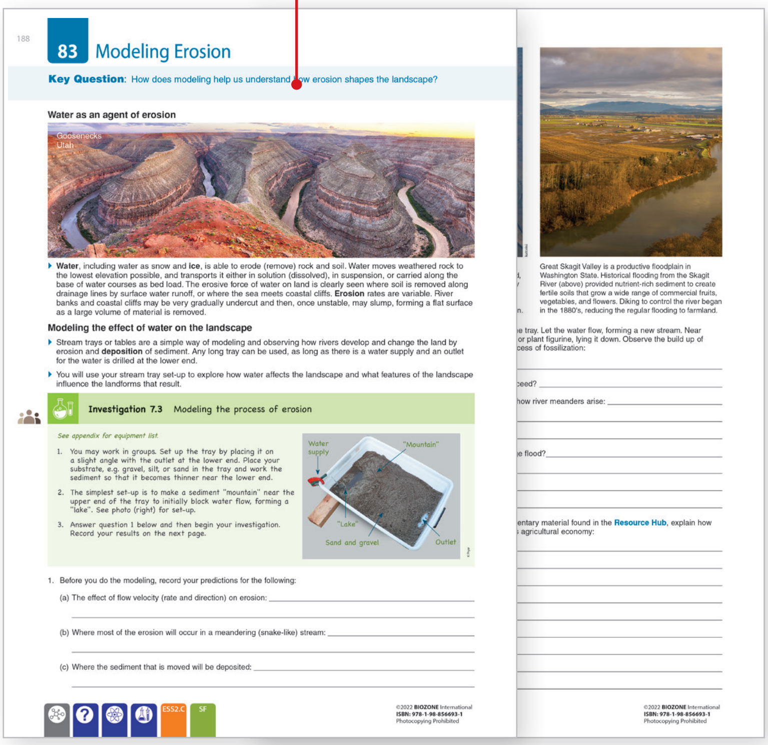




Students have many opportunities to explore concepts through a variety of activities including practical investigations, creating models, analyzing or using second hand data, or interpreting diagrams. This allows students to explain phenomena by building on what they discovered through exploration. In this example, students use a simple, practical investigation to **EXPLAIN** water's role in erosion via frost wedging.

Students are encouraged to use scientific principles and logical reasoning to construct explanations and devise solutions to the problems presented to them. After sound explanations of phenomena are developed, students have an opportunity to **ELABORATE**, applying their understanding to new phenomena or using their experience to develop or refine engineering solutions to relevant problems. Where incorporated, **EVALUATE** sections can be used for formative assessment if you wish. In this example, students apply their knowledge of erosion and deposition to explain their effects on agriculture along a flood plain.





Practical Investigations

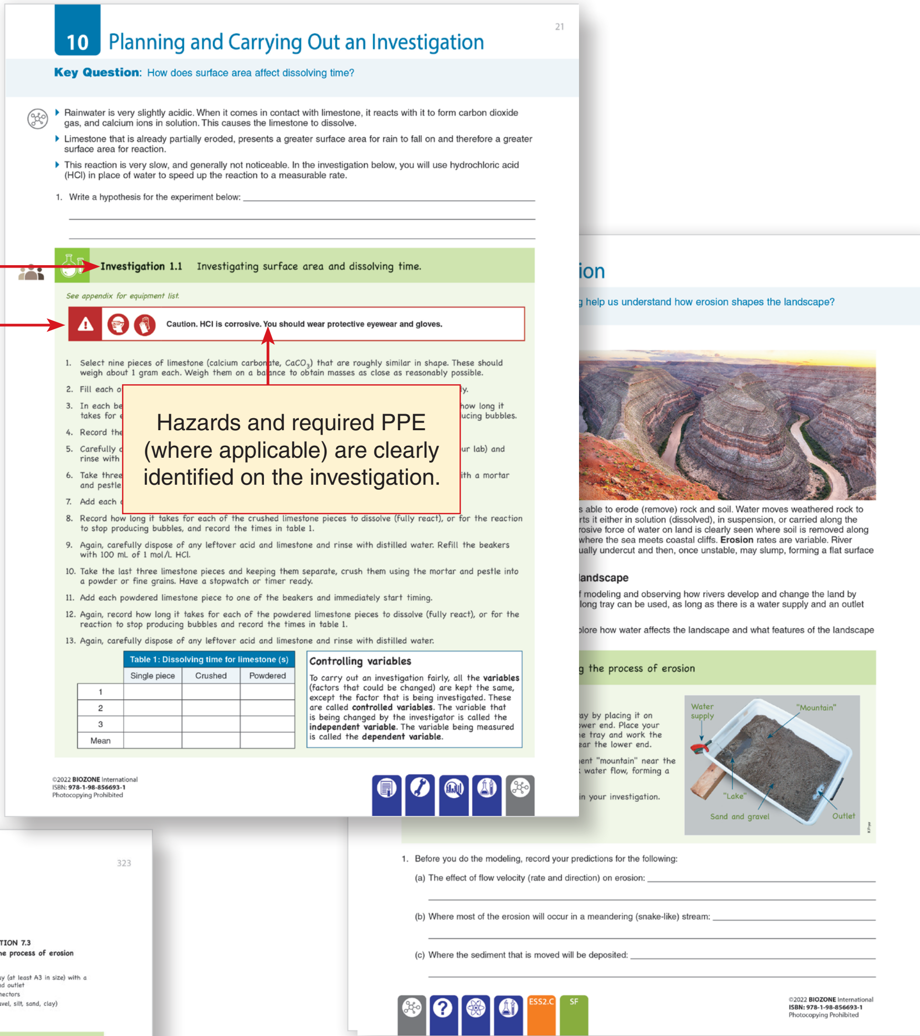
Throughout *Earth and Space Sciences for NGSS*, students are given opportunities to explore phenomena through experimentation. These **investigative phenomena** are opportunities for students to develop competency in laboratory procedures, to practice and refine skills in observation and analysis, and to manipulate data. Some investigations act as stimulus material, while others require students to take what they have already learned and apply their knowledge to a more complex scenario.

The investigations provide an excellent opportunity for collaborative work and will stimulate discussion and the sharing of ideas. You may wish to pair students of different abilities together. Confident students can guide and encourage less able students and, in this relaxed environment, striving students will be encouraged to share their own observations and thoughts. Collaboration through paired practical work provides an excellent opportunity for English language learners to interact in meaningful ways to extend their English language and scientific vocabulary.

Each investigation is clearly numbered sequentially through the chapter.

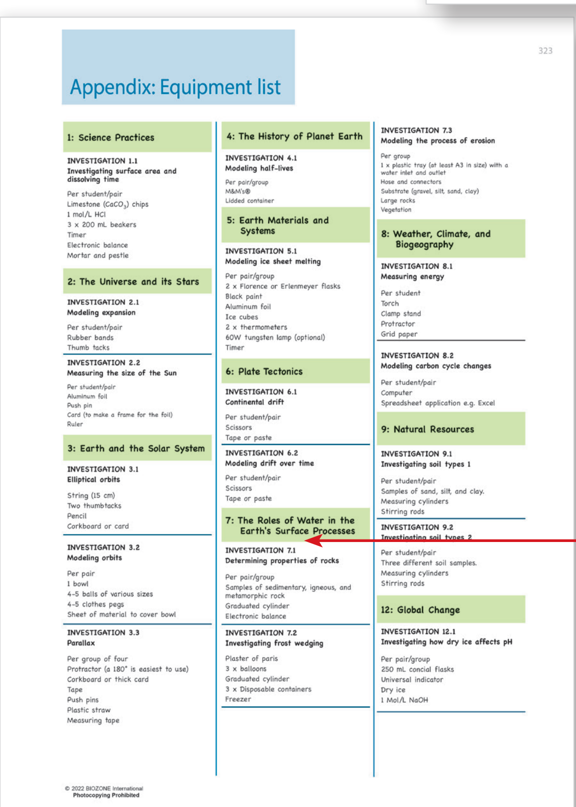
The investigations provide students with health and safety information at the start of the investigation.

- Ensure your students read through the procedure fully *before beginning* the investigation.
- Highlight any hazardous or important steps, and make sure the students follow your directions.



Hazards and required PPE (where applicable) are clearly identified on the investigation.

Equipment list



No kits are required for the investigations.

The investigations have been designed using everyday materials and equipment found in most high school laboratories.

A list of the equipment and chemicals required for each investigation is provided in the appendix of the Student Edition.

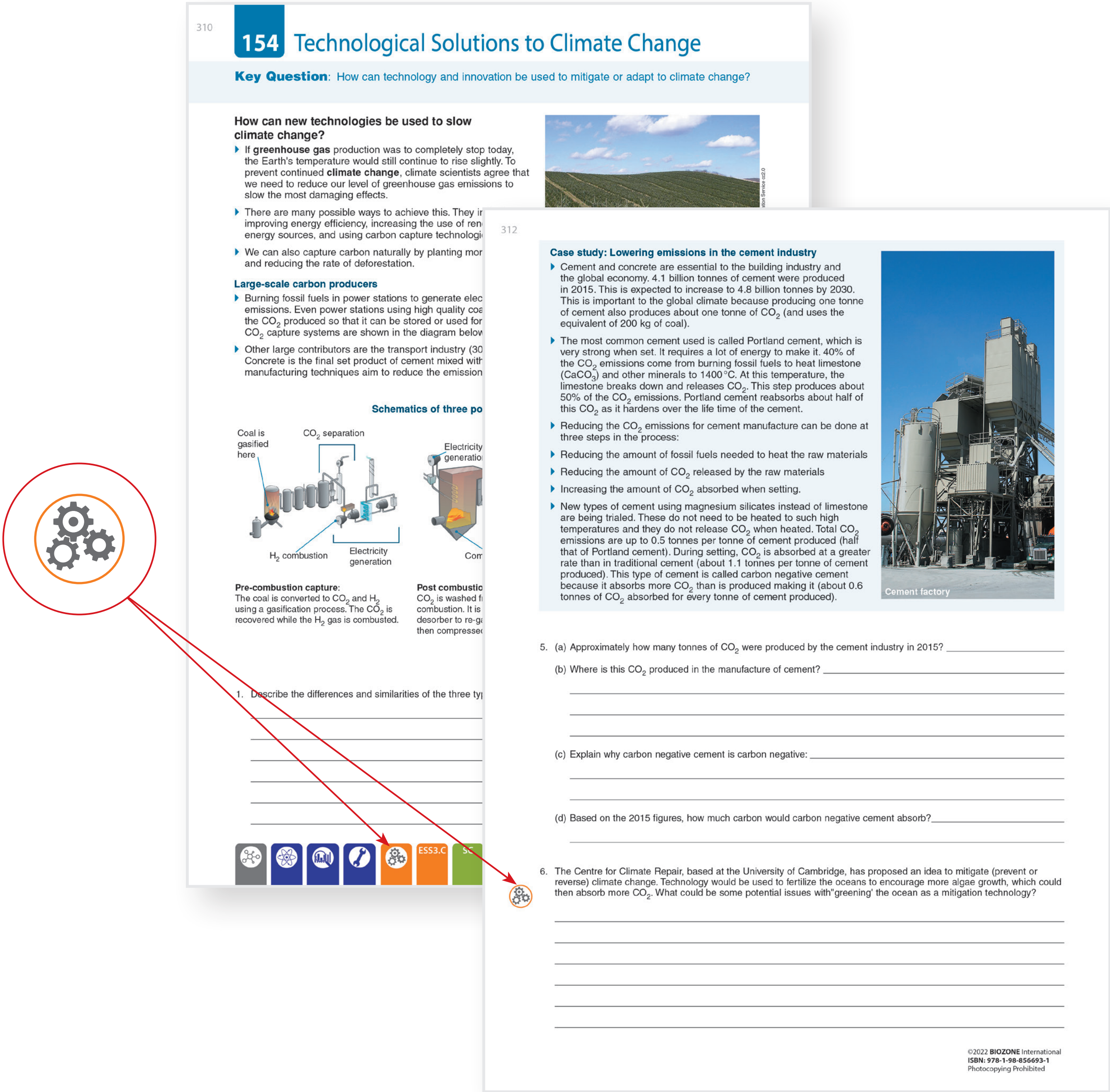
Engineering Design Solutions

At high school, students are expected to analyze major global issues and apply strategic thinking and problem solving to design possible solutions to a specific problem. Often, their solutions include taking into consideration scientific knowledge, the use of technology, and the impact of the solution on society.

Engineering Design (ETS) standards are indicated throughout the NGSS framework. They are incorporated into this title through the integration of engineering and design challenges, where appropriate. Typical Engineering Design tasks include analyzing problems, developing solutions using engineering, evaluating a design solution based on costs and benefits, or modeling a design solution. These activities provide students with an opportunity to apply their knowledge within a design challenge and think outside the box to come up with potential solutions.

The ETS components are indicated in the chapter introduction of the Teacher's Edition, and also in the 3D summary tables in the Classroom Guide. They are also identified through the tab system on the activity itself (bottom of page and margin). Such tasks are usually examples of ELABORATE or EVALUATE as they involve the students applying what they have learned to solve a problem. As such, they also make good tasks for formative or summative assessment.

The ETS icon at the bottom of the page and in the margin identifies when an ETS is covered.


310

154 Technological Solutions to Climate Change

Key Question: How can technology and innovation be used to mitigate or adapt to climate change?

How can new technologies be used to slow climate change?

- If **greenhouse gas** production was to completely stop today, the Earth's temperature would still continue to rise slightly. To prevent continued **climate change**, climate scientists agree that we need to reduce our level of greenhouse gas emissions to slow the most damaging effects.
- There are many possible ways to achieve this. They in improving energy efficiency, increasing the use of ren energy sources, and using carbon capture technologi
- We can also capture carbon naturally by planting mor and reducing the rate of deforestation.

Large-scale carbon producers

- Burning fossil fuels in power stations to generate elec emissions. Even power stations using high quality coa the CO_2 produced so that it can be stored or used for CO_2 capture systems are shown in the diagram below
- Other large contributors are the transport industry (30 Concrete is the final set product of cement mixed with manufacturing techniques aim to reduce the emission

Schematics of three po

Pre-combustion capture: The coal is converted to CO_2 and H_2 using a gasification process. The CO_2 is recovered while the H_2 gas is combusted.

Post combustio CO_2 is washed fi combustion. It is desorber to re-ga then compresse

1. Describe the differences and similarities of the three ty

ESS3.C

312

Case study: Lowering emissions in the cement industry

- Cement and concrete are essential to the building industry and the global economy. 4.1 billion tonnes of cement were produced in 2015. This is expected to increase to 4.8 billion tonnes by 2030. This is important to the global climate because producing one tonne of cement also produces about one tonne of CO_2 (and uses the equivalent of 200 kg of coal).
- The most common cement used is called Portland cement, which is very strong when set. It requires a lot of energy to make it. 40% of the CO_2 emissions come from burning fossil fuels to heat limestone ($CaCO_3$) and other minerals to 1400 °C. At this temperature, the limestone breaks down and releases CO_2. This step produces about 50% of the CO_2 emissions. Portland cement reabsorbs about half of this CO_2 as it hardens over the life time of the cement.
- Reducing the CO_2 emissions for cement manufacture can be done at three steps in the process:
- Reducing the amount of fossil fuels needed to heat the raw materials
- Reducing the amount of CO_2 released by the raw materials
- Increasing the amount of CO_2 absorbed when setting.
- New types of cement using magnesium silicates instead of limestone are being trialed. These do not need to be heated to such high temperatures and they do not release CO_2 when heated. Total CO_2 emissions are up to 0.5 tonnes per tonne of cement produced (half that of Portland cement). During setting, CO_2 is absorbed at a greater rate than in traditional cement (about 1.1 tonnes per tonne of cement produced). This type of cement is called carbon negative cement because it absorbs more CO_2 than is produced making it (about 0.6 tonnes of CO_2 absorbed for every tonne of cement produced).

Cement factory

5. (a) Approximately how many tonnes of CO_2 were produced by the cement industry in 2015?
   (b) Where is this CO_2 produced in the manufacture of cement?
   (c) Explain why carbon negative cement is carbon negative:
   (d) Based on the 2015 figures, how much carbon would carbon negative cement absorb?

6. The Centre for Climate Repair, based at the University of Cambridge, has proposed an idea to mitigate (prevent or reverse) climate change. Technology would be used to fertilize the oceans to encourage more algae growth, which could then absorb more CO_2. What could be some potential issues with "greening" the ocean as a mitigation technology?

©2022 BIOZONE International
ISBN: 978-1-98-856693-1
Photocopying Prohibited

Evaluating Student Performance

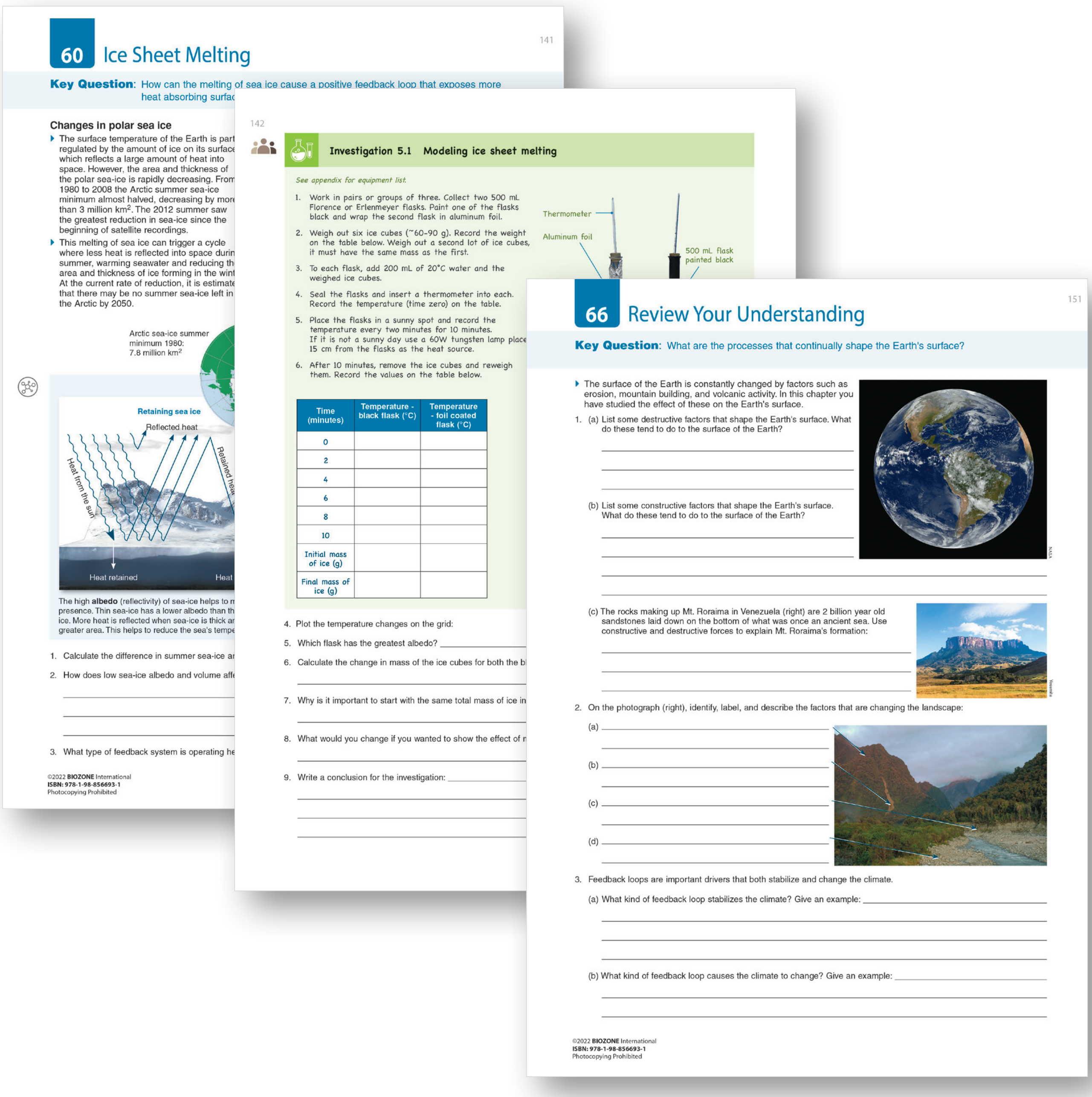
Earth and Space Sciences for NGSS provides ample opportunity for students to demonstrate their understanding and proficiency in all three dimensions of the standards. Opportunities for both formative and summative assessment are provided.

Activities and assessments have been designed to be three-dimensional in their approach, with the goal of enabling achievement of specific Performance Expectations (PEs). Performance Expectations are not always met through completion of one activity or assessment, but may be accomplished through the completion of a connected suite of tasks (as intended by the framework).

Assessments involve a variety of tasks appropriate to a 3D approach, e.g. constructing models, analyzing and interpreting data, explaining, and communicating understanding through short and long answers, drawings, calculations, group work, design, and problem solving. The structure of the tasks is such that students use specific Science and Engineering Practices and apply relevant Crosscutting Concepts to demonstrate their understanding of Disciplinary Core Ideas.

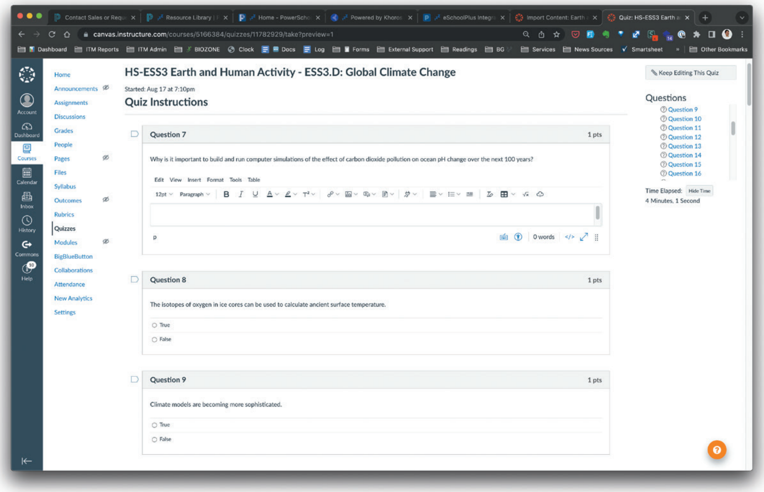
FORMATIVE ASSESSMENT

Formative assessments can be chosen by the teacher to determine how a student's knowledge is progressing within a selected topic. We suggest that 'ELABORATE' and 'EVALUATE' activities be used for formative assessment. These may incorporate some aspect of a Performance Expectation, with the goal being to build confidence. Teachers can revise their instruction, revisit material, or set further tasks if a student is having difficulty with the material. The anchoring phenomenon activity and revisiting the anchoring phenomenon (Review Your Understanding) near the end of each chapter, and the Test Banks (CG12) also provide ways to evaluate student understanding.



TEST BANKS

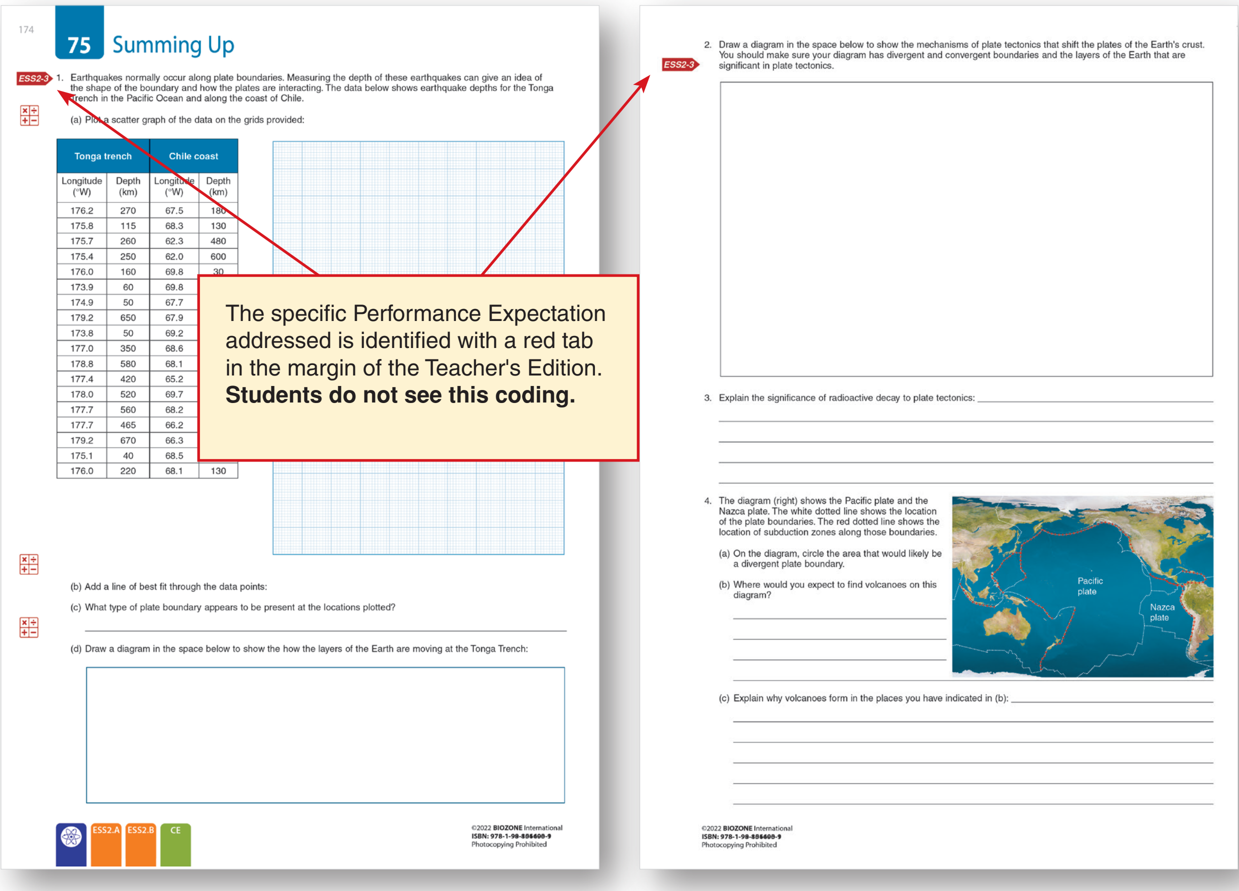
- BIOZONE's Test Banks have been designed to test student understanding of the DCI content within each chapter. They are flexible in how they can be used: select questions for students to complete at the end of each activity, or set a test at the end of a chapter.
- These test content knowledge, and take the form of:
  - Multiple choice
  - Modified True/False
  - Matching
  - Yes/No
  - True/False
  - Multiple response
  - Short answer
  - Numeric response
- Test bank questions are formatted for ingestion into test generator software such as ExamView and Illuminate.
- Questions can be edited and can be used in other formats such as Google forms, Quizlet, or Kahoot for variation.



SUMMATIVE ASSESSMENT

Summing up tasks at the close of each chapter can be used as a formal summative testing moment to evaluate student skills, understanding, and application of knowledge. These tasks are designed to meet part, or all of, one or more Performance Expectations. Material to address specific Performance Expectations is identified with a red tab in the margin throughout the Teacher's Edition. Performance Expectations are also identified in the chapter introduction, and in the tables summarizing BIOZONE's 3D approach by chapter (CG23).

Note: All coding associated with assessment is hidden from the student and is available only in teachers' materials.



Summative assessments are three dimensional assessments of student understanding, including but not restricted to:

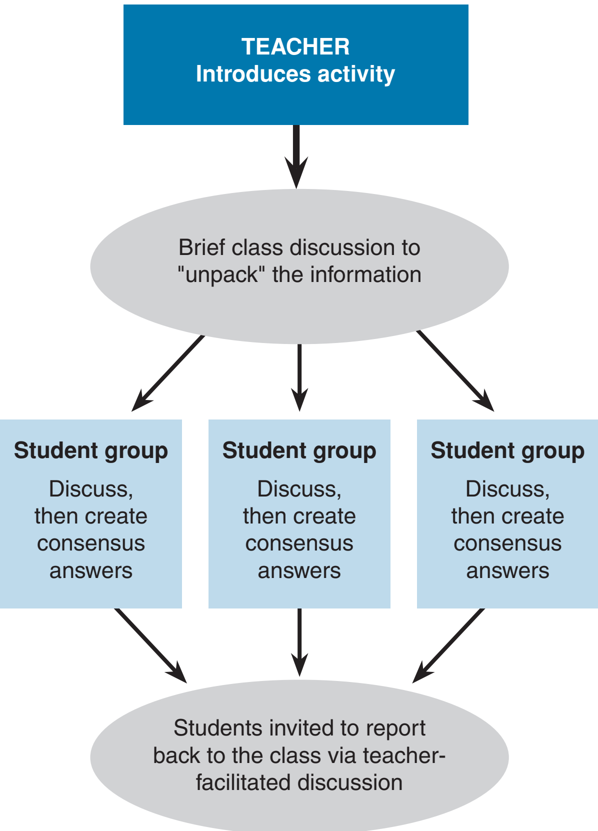
• Short answer questions • Long answer questions • Graphing • Data analysis and interpretation • Modeling

Teaching Strategies for Classroom Use

Achieving effective differential instruction in classes is a teaching challenge. Students naturally have mixed abilities, varying backgrounds in the subject, and different language skills. Used effectively, BIOZONE's worktexts and supporting resources can make teaching a mixed ability class easier. Here, we suggest some approaches for differential instruction.

MAKING A START

Regardless of which activity you might be attempting in class, a short introduction to the task by the teacher is a useful orientation for all students. You may want to use BIOZONE WORLD for this. For collaborative work, the teacher can then divide the class into appropriate groups, each with a balance of able and less able students. Depending on the activity, the class may regroup at the end of the lesson for discussion and to review answers.



Using collaboration to maximize learning outcomes

- The structure of *Earth and Space Sciences for NGSS* allows for a flexible approach to unpacking the content with your students.
- The content can be delivered in a way to support collaboration, where students work in small groups to share ideas and information to answer and gain a better understanding of a topic, or design a solution to a problem.
- By working together to ask questions and evaluate each other's ideas, students maximize their own and each other's learning opportunities. They are exposed to ideas and perspectives they may not have come up with on their own.
- Collaboration, listening to others, and voicing their own ideas is valuable for supporting English language learners and developing their English and scientific vocabularies.
- Use a short, informal, collaborative learning session to encourage students to exchange ideas about the answer to a question. Alternatively, collaboration may take a more formal role that lasts for a longer period of time, e.g. assign groups to work together for a practical activity, to research an extension question, or design a solution to a problem.

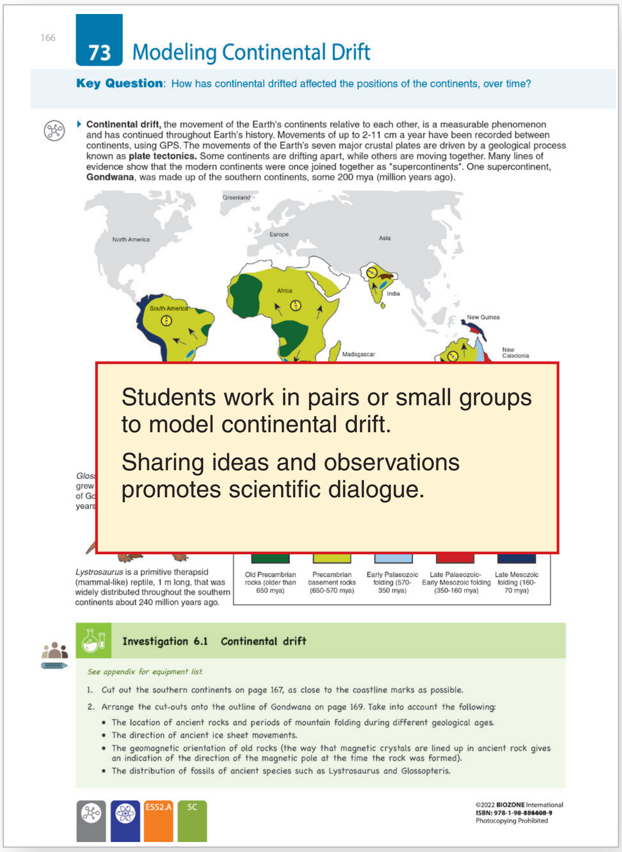
The teacher introduces the topic. They provide structure to the session by providing background information and setting up discussion points and clear objectives. Collaboration is emphasized to encourage participation from the entire group. If necessary, students in a group can be assigned specific tasks.

Students work in small groups so that everyone's contribution is heard. They collaborate, share ideas, and engage in discourse. The emphasis is on discussing questions and formulating a consensus answer, not just sharing ideas.

At the end of the session, students report back on their findings. Each student should have enough knowledge to report back on the group's findings. Reporting consists primarily of providing answers to questions, but may involve presenting a report, model, or slide show, or contributing to a debate.

Peer to peer support

- **Peer-to-peer** and **collaborative learning** is emphasized throughout the book, and is particularly valuable for more challenging activities in which the content is more complex, or the questions require students to draw on several areas of their knowledge to solve a problem.
- Stronger students can assist their peers and both groups benefit from verbalizing their ideas. Students for whom English is a second language can ask their classmates to explain unfamiliar terms and this benefits the understanding of both parties.
- **Practical investigations** are an ideal vehicle for peer-to-peer learning. Students can work together to review their results, ask and answer questions, and describe phenomena. There are also opportunities for students to collaborate using models, shown below.



166

73 Modeling Continental Drift

Key Question: How has continental drifted affected the positions of the continents, over time?

- **Continental drift,** the movement of the Earth's continents relative to each other, is a measurable phenomenon and has continued throughout Earth's history. Movements of up to 2-11 cm a year have been recorded between continents, using GPS. The movements of the Earth's seven major crustal plates are driven by a geological process known as **plate tectonics.** Some continents are drifting apart, while others are moving together. Many lines of evidence show that the modern continents were once joined together as "supercontinents". One supercontinent, **Gondwana**, was made up of the southern continents, some 200 mya (million years ago).

Students work in pairs or small groups to model continental drift.

Sharing ideas and observations promotes scientific dialogue.

Lystrosaurus is a primitive therapsid (mammal-like) reptile, 1 m long, that was widely distributed throughout the southern continents about 240 million years ago.

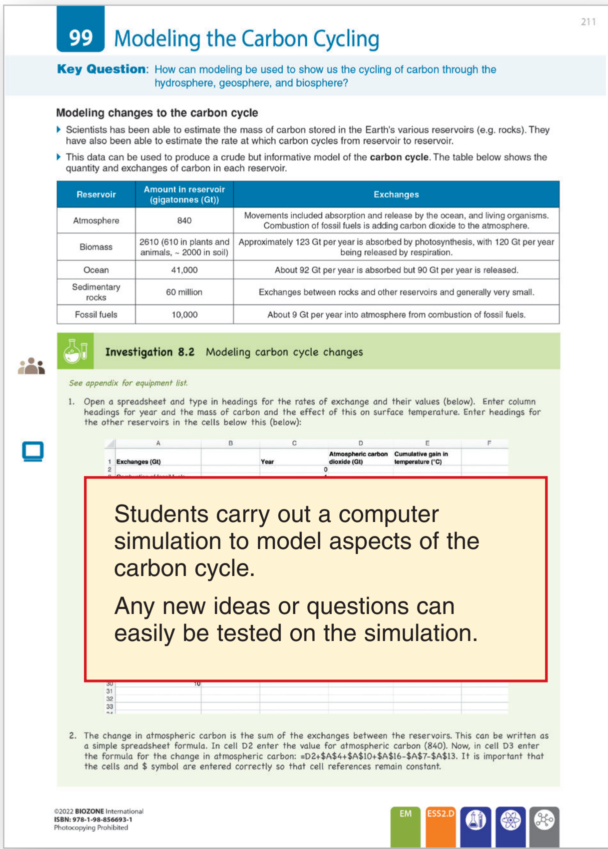
Old Precambrian rocks (older than 650 mya) | Precambrian basement rocks (650-570 mya) | Early Palaeozoic folding (570-350 mya) | Late Palaeozoic-Early Mesozoic folding (350-160 mya) | Late Mesozoic folding (160-70 mya)

Investigation 6.1 Continental drift

See appendix for equipment list.

1. Cut out the southern continents on page 167, as close to the coastline marks as possible.
2. Arrange the cut-outs onto the outline of Gondwana on page 169. Take into account the following:
   - The location of ancient rocks and periods of mountain folding during different geological ages.
   - The direction of ancient ice sheet movements.
   - The geomagnetic orientation of old rocks (the way that magnetic crystals are lined up in ancient rock gives an indication of the direction of the magnetic pole at the time the rock was formed).
   - The distribution of fossils of ancient species such as Lystrosaurus and Glossopteris.

ESS2.A SC



211

99 Modeling the Carbon Cycling

Key Question: How can modeling be used to show us the cycling of carbon through the hydrosphere, geosphere, and biosphere?

Modeling changes to the carbon cycle

- Scientists has been able to estimate the mass of carbon stored in the Earth's various reservoirs (e.g. rocks). They have also been able to estimate the rate at which carbon cycles from reservoir to reservoir.
- This data can be used to produce a crude but informative model of the **carbon cycle**. The table below shows the quantity and exchanges of carbon in each reservoir.

Reservoir	Amount in reservoir (gigatonnes (Gt))	Exchanges
Atmosphere	840	Movements included absorption and release by the ocean, and living organisms. Combustion of fossil fuels is adding carbon dioxide to the atmosphere.
Biomass	2610 (610 in plants and animals, ~ 2000 in soil)	Approximately 123 Gt per year is absorbed by photosynthesis, with 120 Gt per year being released by respiration.
Ocean	41,000	About 92 Gt per year is absorbed but 90 Gt per year is released.
Sedimentary rocks	60 million	Exchanges between rocks and other reservoirs and generally very small.
Fossil fuels	10,000	About 9 Gt per year into atmosphere from combustion of fossil fuels.

Investigation 8.2 Modeling carbon cycle changes

See appendix for equipment list.

1. Open a spreadsheet and type in headings for the rates of exchange and their values (below). Enter column headings for year and the mass of carbon and the effect of this on surface temperature. Enter headings for the other reservoirs in the cells below this (below):

	A	B	C	D	E	F
1	Exchanges (Gt)		Year	Atmospheric carbon dioxide (Gt)	Cumulative gain in temperature (°C)	
2				0		

Students carry out a computer simulation to model aspects of the carbon cycle.

Any new ideas or questions can easily be tested on the simulation.

2. The change in atmospheric carbon is the sum of the exchanges between the reservoirs. This can be written as a simple spreadsheet formula. In cell D2 enter the value for atmospheric carbon (840). Now, in cell D3 enter the formula for the change in atmospheric carbon: =D2+$A$4+$A$10+$A$16-$A$7-$A$13. It is important that the cells and $ symbol are entered correctly so that cell references remain constant.

EM ESS2.D

Interactive revision of tasks in class

Review answers in class via BIOZONE WORLD
The teacher view in BIOZONE WORLD has model answers which can be toggled on and off using the show/hide buttons on an activity page.

View activities in BIOZONE WORLD on a shared screen and reveal the answers as required. This is ideal for:

- Providing a concise model answer after a group or class discussion.
- Self marking by students. Students can amend their answer if necessary, providing a powerful secondary learning moment.
- Providing a quick review of answers if time is short.

Students benefit from the feedback in class, where questions can be addressed, and teachers benefit by having students self-mark their work and receive helpful feedback on their responses.

This approach is particularly suited to activities with questions requiring a discussion, as students will be able to clarify some aspects of their responses. Stronger students can benefit by contributing to the explanatory feedback and class discussion.

NGSS for collaboration and discovery

- BIOZONE's *Earth and Space Sciences for NGSS* provides multiple chances for collaboration and discovery. By working together and sharing ideas, students are exposed to different perspectives and levels of knowledge about phenomena.
- NGSS requires deeper student engagement, with less emphasis on facts and more on understanding. By exploring principles and concepts within a context, students are more easily able to apply these principles to new phenomena.
- BIOZONE's *Earth and Space Sciences for NGSS* provides a range of activities to develop student understanding, based on the NGSS framework. These include encouraging students to think about and share what they already know and then build on this knowledge by exploring and explaining phenomena.

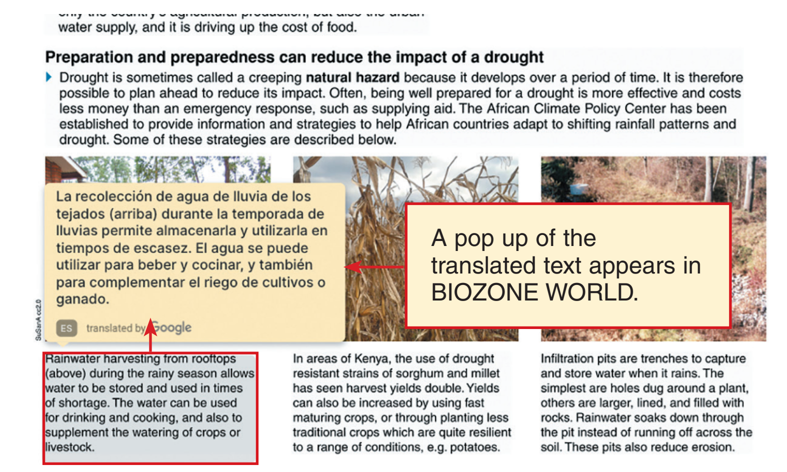
Student A is capable. He helps to lead the discussion and records the discussion in a structured way.

Students B and C are also capable but less willing to lead discussion. They will add ideas to the discussion but need a little direction from A to do so.

Student D is less able but gains ideas and understanding from the discussion of students A, B, and C. She may add to the discussion as she gains confidence in the material being studied.

How are English Language Learners Supported?

BIOZONE has several support mechanism in place to support English Language Learners (ELLs) in your classroom. In the printed books, a **glossary** of important key terms is provided in English and Spanish. In the digital platform, a **translation function** supports ELLs in their learning journey. More information on these features is provided below.



Encourage all students to use the **glossary** to build scientific literacy and become comfortable with using the terms appropriately. The glossary is available in English and Spanish to help students learn key terms.

Key terms, which have been **bolded** within an activity, are included in the glossary. Key terms are only bolded the first time they appear within an activity.

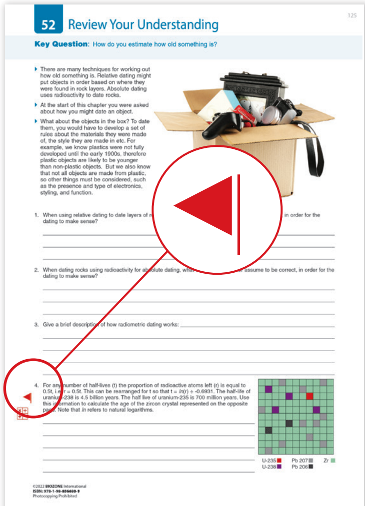
Translation function

BIOZONE WORLD, our digital platform, provides a translation feature to support to students who have English as a second language. The content can be translated into ~150 languages.

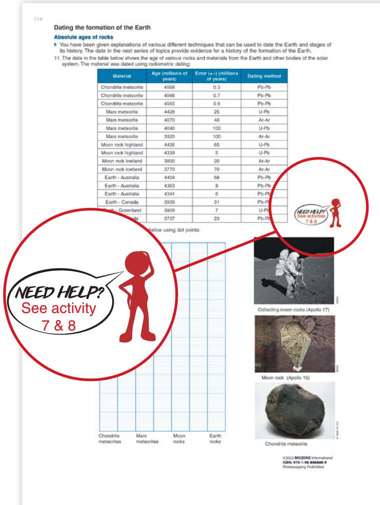
Simply activate the translation feature, select the language for translation, and roll the cursor over the text to be translated. A pop up box of the translated text appears on the page. The English text is still visible. Having both languages visible supports students with their English language development while having the reassurance of their first language accessible.

Differentiated Learning

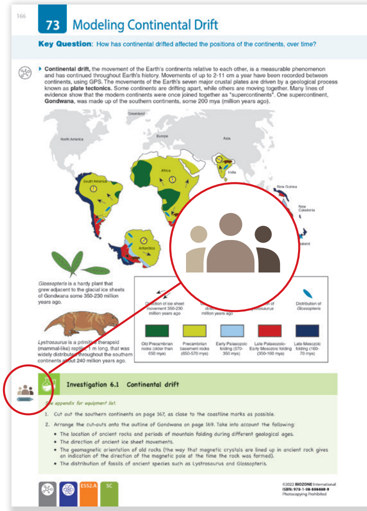
The structure of *Earth and Space Sciences for NGSS* promotes differentiated instruction and has been designed to cater for students of all abilities. BIOZONE's collaborative approach to science inquiry encourages all students to share their ideas and knowledge with their peers, while at the same time broadening their own understanding of phenomena. There are several ways you can use *Earth and Space Sciences for NGSS* to implement differential instruction in your classroom:



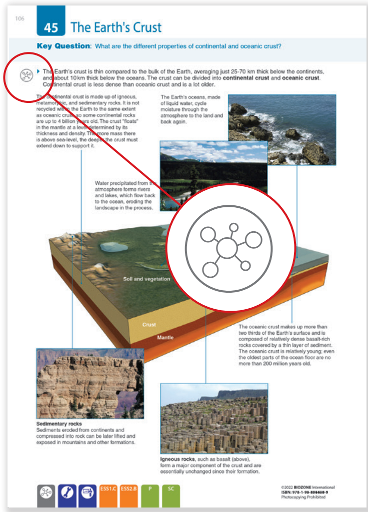
Extension Questions: Red flag codes beside a section or question (in the Teacher's Edition) indicate the material is suitable as extension material for more able students. All students may attempt this material, but some students may need extra guidance from the teacher.



Need Help? Icon: The red NEED HELP? icon identifies where material is available in the Science Practices chapter to support a particular math or science practice skill. You can set these activities as homework as a refresher before the students attempt the activity needing the skill. Encourage students to refer to the Science Practices chapter often.

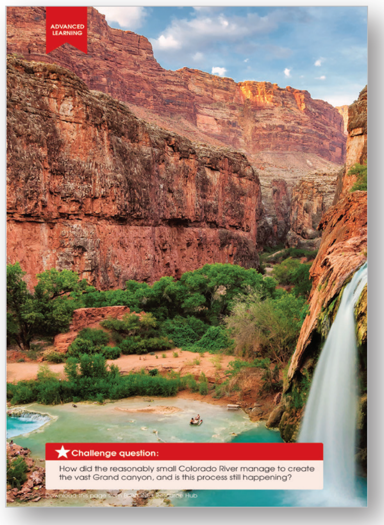


Collaboration Icon: A group symbol indicates where students can work together. Group work provides opportunities for student collaboration and peer-to-peer support to explore phenomena. Working in groups, students can experience the benefits of collaboration in the scientific process of discovery. By speaking and listening to each other, communication skills and scientific vocabulary are extended.



Resource Hub: the Resource Hub content is designed to support learners of all abilities and learning styles engage with the content of *Earth and Space Sciences for NGSS* (CG18). Use the 3D models, videos, games, and animations to help striving learners with their understanding of content. Tags identify material suitable for gifted and talented students and material for teachers.

Glossary: Glossaries have been provided in the back of the Student Edition to help improve scientific literacy. Encourage students to refer to the glossary whenever they are unsure about the meaning of a key term. Key terms are identified by **bold black text**. The glossary is provided in both English and Spanish (CG15).



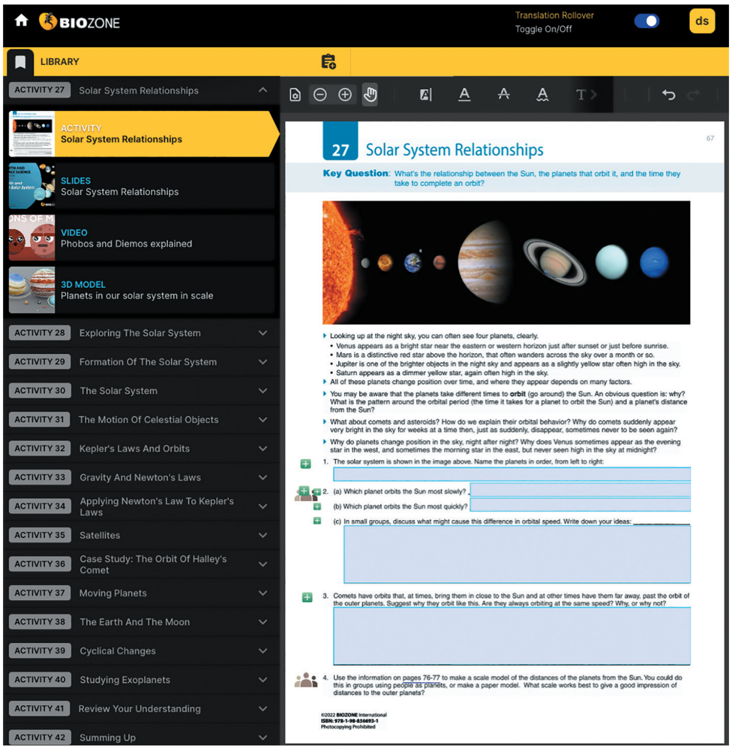
Challenge Question: Do you ever need an extra challenge for more able students? The Teacher's Edition includes challenge questions. These are useful for extending gifted and talented students in particular, but any keen students can have a go! Challenge questions are found in the Teacher's Edition, and can be downloaded from BIOZONE's **Resource Hub**, where it is the first link for each chapter.

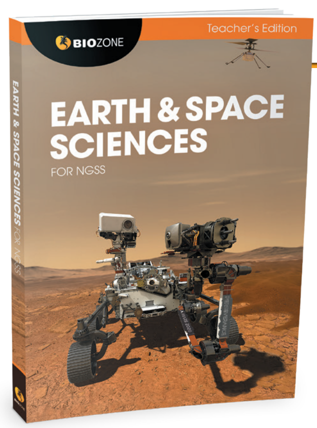
The Teacher Toolkit

BIOZONE's **Teacher Toolkit** is a suite of resources specifically developed to help you plan and deliver an engaging NGSS program. Additional assessment tools are provided, allowing teachers to easily assess student understanding. A brief description of the tools is provided below and in the following pages.

BIOZONE WORLD

- BIOZONE WORLD, our digital science platform, brings our digital worktexts and rich collection of digital resources together in a single location for easy use. Click on an activity to access the additional resources provided. These include: presentation slides, interactive 3D models, and curated videos and weblinks. Educators can easily plan lessons, assign work, and grade student responses using BIOZONE WORLD.
- Students' access to BIOZONE WORLD allows them to use tools to markup, highlight, and bookmark content. They can also answer questions online, and submit their work for review or grading. Students have access to the curated collection of digital resources (presentation slides, 3D models, and curated videos and weblinks).
- Teacher access to BIOZONE WORLD includes the features available to students plus teacher-only additional features, including:
    - Managing class student enrolments.
    - The ability to view, grade, and give feedback on submitted student work.
    - Forced hand-in feature.
    - Ability to display the content on a shared screen (e.g. interactive whiteboard) to introduce or review an activity, or highlight areas of particular importance, e.g. an important step in a practical investigation.
    - Model answers in place. Show/hide buttons toggle answers on and off; ideal for sharing data or answers with students.
      Students do not have access to model answers on BIOZONE WORLD.
- The translation tool within BIOZONE WORLD translates the content into over 150 languages.
- Find out more: **biozone.com/us/biozone-world**





TEACHER'S EDITION - PRINT

The *Earth and Space Sciences for NGSS* Teacher's Edition is the teacher's companion to the student worktext. Use this resource to gain insight into the features of *Earth and Space Sciences for NGSS* and how to use them in your planning, delivery, and assessment.

The **Classroom Guide** provides a guide to best use of BIOZONE's resources. It includes teacher notes (CG20), covers strategies for teaching in a differentiated classroom, information about the assessment tools, the benefits of collaborative learning, and supporting delivery of the three dimensions and Common Core State Standards. An overview of the Teacher Toolkit is also provided. The Teacher's Edition follows the same flow as the Student Edition, and all suggested model answers are in place. Additional teacher coding identifies G&T extension material, Common Core State Standards, and Performance Expectations. Long answers, requiring more space than is allowed on the page, are included at the back of the Teacher's Edition.

RESOURCE HUB

The BIOZONE **Resource Hub** is a **free resource**, available to both students and teachers. It offers a curated collection of Open Educational Resources (OER) specifically chosen to support the content of the worktext. Resources include videos, animations, games, 3D models, spreadsheets, and source material.

Content on the BIOZONE **Resource Hub** can be accessed by both print and digital users. **Print users** can access the material using the QR code in the worktext or bookmark the link provided (below right). For **BIOZONE WORLD users**, these same resources are ingested into the platform and automatically appear with the selected activity.

The BIOZONE **Resource Hub** is an effective tool to engage students of all abilities within a differentiated classroom. Most resources can be used by students of all abilities. 3D models, videos, games, and simulations are great tools for engaging students in a topic, or supporting striving students in their learning journey.

Some components have been tagged as extension material and can be used to extend more capable or gifted students. These types of resources may require more reading or synthesis of information. Our spreadsheet models can be used as is, or you can have students graph the information themselves. You may wish to challenge more capable students to build their own models, or manipulate the ones provided to observe the outcomes.

Some material is tagged as a teacher resource. Teacher resources often provide background or additional material to an activity. Capable students, or students with a particular interest in the topic can be assigned this material at your discretion.

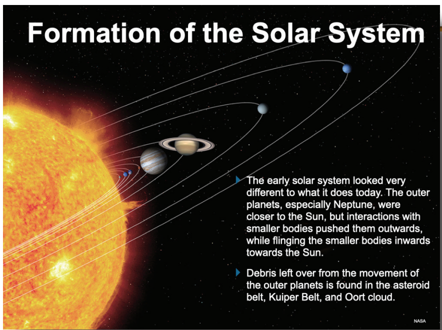
BIOZONE **Resource Hub** content is easily shared with your students through your LMS. You can provide notes and guidance about what you want students to do with the resource.
The BIOZONE **Resource Hub** can be accessed directly via the QR code below:

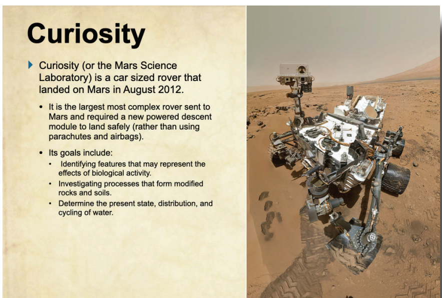
Or bookmark the following link:

www.BIOZONEhub.com

Then enter the code in the text field **NES2-6931**

PRESENTATION SLIDES



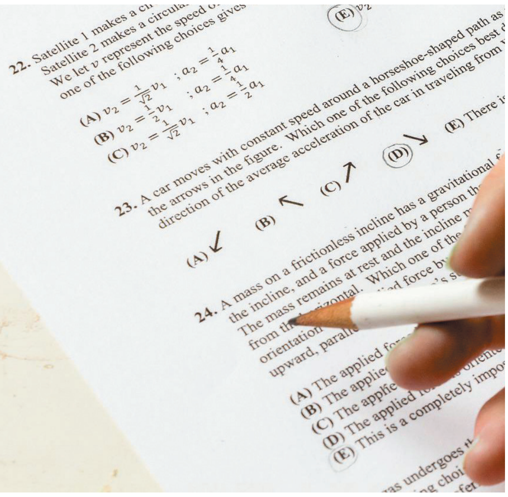


Presentation Slides are a very popular way for teachers to deliver a lesson in a presentation style format. Presentation Slides are a useful delivery tool in both face to face or remote teaching.

The Presentation Slides are a sizeable collection of slides specifically designed to support and enhance the content of the worktext. A set of slides is available for each chapter of *Earth and Space Sciences for NGSS*. In some instances, the slide sets contain extra material or examples not contained within the worktext, and are excellent for providing new scenarios for students to work on.

The Presentation Slides are fully ingested into BIOZONE WORLD and automatically appear with the selected activity.

TEST BANKS

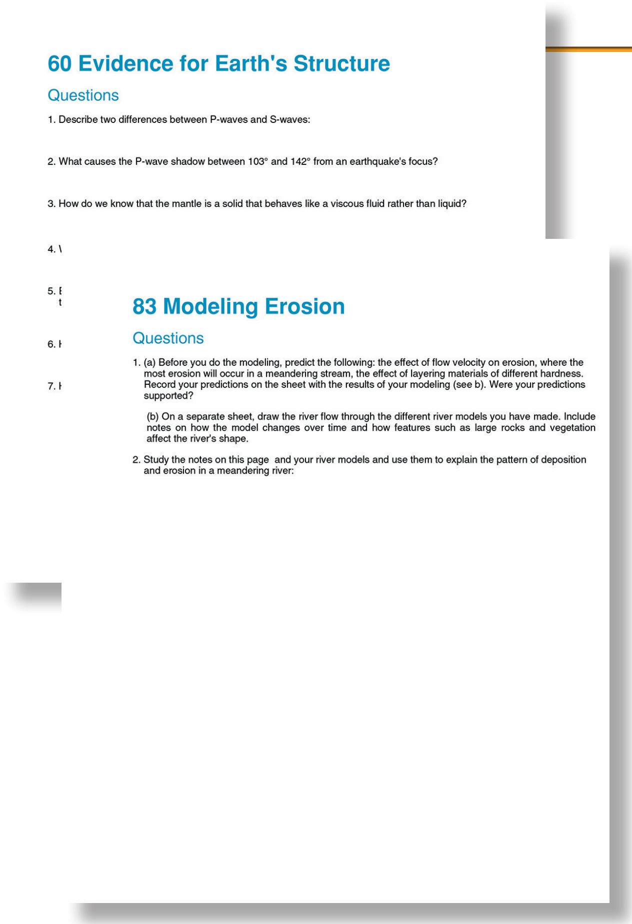


Assessments within *Earth and Space Sciences for NGSS* have been designed on the most part to be fully three dimensional, to assess the Performance Expectations specified in the NGSS framework. However, we understand that a variety of assessment tools are useful within a differentiated classroom. A range of opportunities to test student understanding enables teachers to identify gaps and misconceptions and to be able to address these before a formal assessment moment.

BIOZONE's Test Banks have been specifically curated to test student understanding of the DCI content of the material. The test bank questions are not three dimensional; however, they complement the three dimensional assessments with the worktext.

A range of question types is available (CG16). The Test Banks are provided in QTI and RTF formats, providing teachers with flexibility in how they deliver and use the questions. Questions are fully editable, teachers can pick and mix questions from the entire suite of questions and edit the wording to customize the tests for individual classrooms.

- Test banks can be ingested into test generator software such as Illuminate and ExamView.
- Encourage student participation by converting the questions into a Kahoot or Quizlet format. Students can work individually, in pairs, or small groups to learn and share ideas in a fun environment. Multiple choice and true/false questions are easily converted to Kahoot quizzes. Review the answers with the class for a quick refresher of key ideas and correct any commonly occurring misconceptions.
- Questions can be easily ingested into LMS in a number of formats, e.g. Google forms, or a Google or word document.
- Test Banks can be used to gauge student understanding at the end of activities, a set of related activities, or at the end of a chapter.



60 Evidence for Earth's Structure

Questions

1. Describe two differences between P-waves and S-waves:

2. What causes the P-wave shadow between 103° and 142° from an earthquake's focus?

3. How do we know that the mantle is a solid that behaves like a viscous fluid rather than liquid?

83 Modeling Erosion

Questions

1. (a) Before you do the modeling, predict the following: the effect of flow velocity on erosion, where the most erosion will occur in a meandering stream, the effect of layering materials of different hardness. Record your predictions on the sheet with the results of your modeling (see b). Were your predictions supported?

   (b) On a separate sheet, draw the river flow through the different river models you have made. Include notes on how the model changes over time and how features such as large rocks and vegetation affect the river's shape.

2. Study the notes on this page and your river models and use them to explain the pattern of deposition and erosion in a meandering river:

QUESTION LIBRARY

The Question Library provides all of the questions from the Student Edition worktext in a format that can be ingested into a range of LMS or other digital delivery tools.

Questions within the worktext are generally scaffolded: easier questions are asked first, to build student confidence, and the questions may become more complex or difficult as students progress through an activity.

The Question Library content is **fully editable**, providing teachers with flexibility and control in assigning questions within a differentiated classroom. The questions can be customized to match a student's learning ability or reading level.

Question Library questions are provided in QTI and RTF formats.

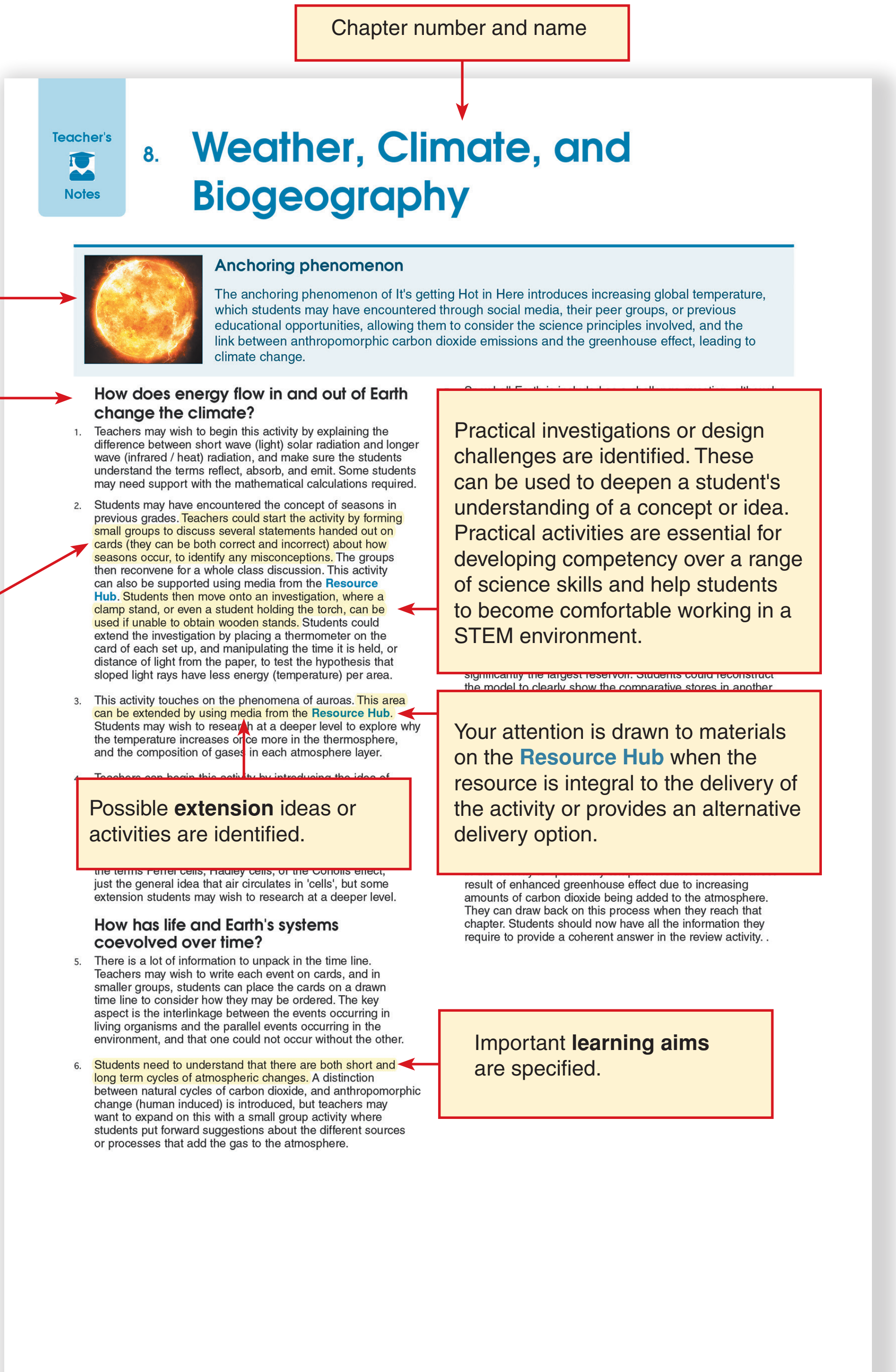
Teacher's Notes

Extended teacher's notes are found at the front of each chapter in the Teacher's Edition of *Earth and Space Sciences for NGSS*. These notes provide context for the material and additional detail for the learning points, matched point for point. Where appropriate, opportunities to incorporate group work, practical activities, or design challenges are explained. Suggestions for differentiated instruction are also provided, including ways to support striving learners, e.g. through peer-to-peer support. Most activities are supported by material on **BIOZONE's Resource Hub**. The Resource Hub provides access to a large collection of free resources to supplement your teaching. It is identified with a hub icon in the margin of both the Student Edition and Teacher's Edition. Where the resource is integral to the delivery of the activity, e.g. online data sets, computer simulations, or spreadsheets, we have indicated this in the teacher's notes.

The **anchoring phenomenon** provides a context for the chapter. We have included some questions you may wish to ask your students to engage them in the topic, and ideas for student engagement.

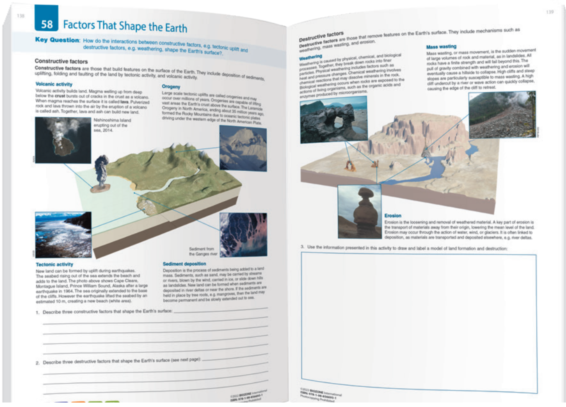
The **guiding questions** and **numbering of learning aims** is the same as in each chapter introduction of the Student Edition and Teacher's Edition (learning aims are matched point for point).

Opportunities for **group work** are identified. They provide opportunities for collaboration and can be used to develop ELA/ELD skills such as speaking and listening, developing language, and research and presentation skills.



BIOZONE's Pedagogy

A worktext approach



BIOZONE's delivery method is a departure from a traditional textbook. We combine the very best features of a textbook with the utility of a workbook, producing a worktext resource. Importantly, the worktext is owned by the student: it is their own resource to utilize. Whether they are using the print or digital version, students customize their worktext with notes and annotations, checking off their progress in the contents and chapter introductions, and input their answers on the pages as they work through the activities.

Using a highly graphical approach and short blocks of text, we deliver textbook quality information in an accessible and engaging way, ensuring students are not overwhelmed by large amounts of information. As students interact with the stimulus material and work through activities, they are encouraged to input their answers directly onto the page. This simple act reinforces the learning moment and forms a record of work as they progress through the material. Students find revision a breeze because the stimulus material, questions, and their answers are in one place.

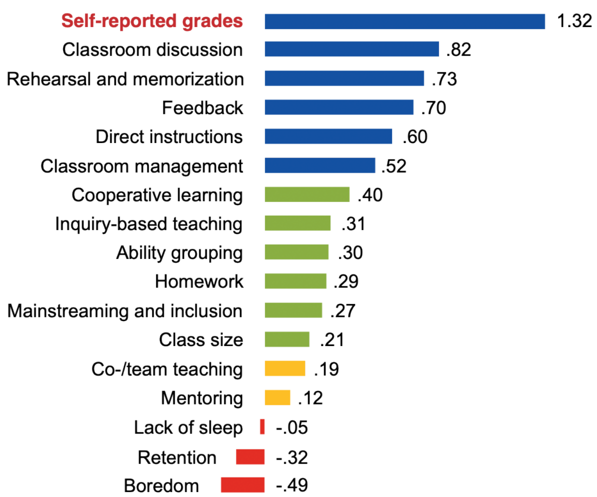
We have included a wide range of activity types in this title. These include practical activities (experimental investigations, modelling, and simulations), research activities, and assessment tasks. The variety of activity types provides flexibility in the way teachers can assign them. For example, work can be assigned to be carried out as homework, completed in class, or set for revision. Teachers can assign students to work on activities individually or set work as a group. The activity based approach simplifies assigning work, and teachers can utilize this approach to set work for substitute teachers in their absence

Not all answers need to be graded!

Within the activities, there are plenty of opportunities for students to record answers to the questions. This approach reinforces the learning moment, provides space for students to record their work, and acts as a revision tool when students are preparing for assessments. This approach does not mean that teachers are expected to review or grade all student responses. We suggest that only key activities or questions are graded. This might be assessment tasks a the end of each chapter or at the conclusion of a unit. You may also choose to grade activities with content that students have traditionally found challenging, or where there is often a misunderstanding of the topic. Teachers can also choose to share answers with students. Sharing the model answers allows students to self report grades: an exercise known to be a powerful pedagogical learning tool (Hattie(2009)). Having access to model answers also allows students to refine their initial response if needed. This provides a powerful second learning moment to consolidate and extend understanding.
Teachers can utilize the show/hide model answer feature in the digital platform to share answers.

Features to accelerate student learning

Student learning can be influenced by many factors. A synthesis of more than 1,400 meta studies by Hattie (2009) involving over 80,000 individual studies and 300 million students has revealed some of the major influences to student learning. Some factors negatively influence student learning (red, right) while others have positive effects (yellow, green, and blue, right). BIOZONE's approach incorporates many of the factors shown to positively influence student learning, these are underlined in red on the diagram (right). By utilizing Earth and Space Sciences for NGSS, these factors are organically incorporated into content delivery and enhance the teacher and learner experience.



Hattie, J. (2009). Visible Learning. Routledge

Identifying CCCs and SEPs by Number

CROSSCUTTING CONCEPTS (CCCs)

CCCs are unifying ideas that apply across all disciplines of science. A CCC connects topics where the same unifying concept underpins the content. A statement for each numbered CCC is provided below. CCCs are identified by number in the tables following and in the embedded coding in the chapter introductions (Teacher's Edition). Statements are paraphrased.

1: Patterns
In grades 9-12, students observe patterns in systems at different scales and cite patterns as evidence for causality in supporting explanations of phenomena. They recognize that classifications or explanations at one scale may need revision using a different scale, thus requiring improved investigations and experiments. They identify and analyze patterns, and use analysis to re engineer and improve designed systems.

2: Cause and effect
In grades 9-12, students understand that empirical evidence is required to differentiate between cause and correlations and to make claims about cause and effect. They suggest cause and effect relationships to explain and predict behaviors in natural and designed systems. They also propose causal relationships by examining what is known about smaller-scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.

3: Scale, proportion, and quantity
In grades 9-12, students understand that the significance of a phenomenon depends on the scale, proportion, and quantity at which it occurs. They recognize that patterns observable at one scale many not be observable or exist at other scales and that some systems can only be studied indirectly. Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another.

4: Systems and system models
In grades 9-12, students investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They use models to simulate the flow of energy, matter, and interactions within and between systems at different scales. They also use models and simulations to predict the behavior of a system and recognize why these predictions have limited precision and reliability. They also design systems to do specific tasks.

5: Energy and matter
In grades 9-12, students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed, only transferred and transformed. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

6: Structure and function
In grades 9-12, students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal a system's function and/or solve a problem. They infer the functions and properties of natural and designed objects and systems from their structure, the way their components are shaped and used, and the molecular substructures of their various materials.

7: Stability and change
In grades 9-12, students understand that much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over short or very periods of time. They see that some changes are irreversible and that negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize that systems can be designed for more or less stability.

SCIENCE & ENGINEERING PRACTICES (SEPs)

SEPs for NGSS are overlapping and interconnected practices that students should know and understand. A statement for each numbered SEP is provided below. SEPs are identified by number in the tables following and in the embedded coding in the chapter introductions (Teacher's Edition).

1: Asking questions and defining problems
"Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations."

2: Developing and using models
"Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s)."

3: Planning and carrying out investigations
"Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual mathematical, physical, and empirical models".

4: Analzying and interpreting data
"Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data."

5: Using mathematics and computational thinking
"Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and non-linear functions, including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simulations are created and used based on mathematical models of basic assumptions."

6: Constructing explanations and designing solutions
"Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories".

7: Engaging in argument from evidence
"Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science."

8: Obtaining, evaluating, and communicating information
"Obtaining, evaluating, and communicating information in 9-12 builds on K-8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs."

Summary of BIOZONE's 3D Approach By Chapter

Science and Engineering Practices (SEPs), Crosscutting Concepts (CCCs), Disciplinary Core Ideas (DCIs), and Performance Expectations (PEs) for each chapter of *Earth and Space Sciences for NGSS* are listed in the tables following. An introductory "Science Practices" chapter is also included. Performance Expectations are met within the chapter and/or the *Summing Up* activity.

1: SCIENCE PRACTICES

Activity	SEP	DCI	CCC	PE
1	1,2	NA	4	NA
2	2	NA	4	NA
3	5	NA		NA
4	2, 5	NA	5	NA
5	1	NA		NA
6	5	NA		NA
7	4	NA	2	NA
8	4, 6, 7	NA		NA
9	4	NA		NA
10	3, 4, 6, 8	NA		NA

2: THE UNIVERSE AND ITS STARS

Activity	SEP	DCI	CCC	PE
12	2	ESS1.A		
13	2	ESS1.A PS4.B	3	
14		ESS1.A	3	
15	2, 6	ESS1.A	5	
16	2, 7	ESS1.A	5, 7	
17	2, 3, 5	ESS1.A	5, 7	
18	2, 3, 5	ESS1.A PS3.D	3, 5	
19 - 21	2	ESS1.A	3, 5	
22	2	ESS1.A	3, 5	
23	2	ESS1.A	5	
24	2, 8	ESS1.A	3, 5	HS-ESS1-3
26	2, 6	ESS1.A	3, 5	HS-ESS1-1, HS-ESS1-2

3: EARTH AND THE SOLAR SYSTEM

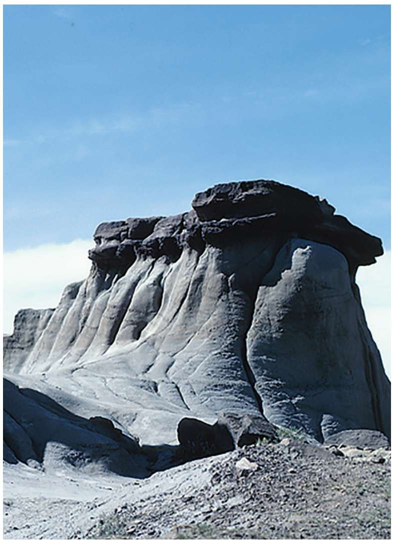
Activity	SEP	DCI	CCC	PE
29			7	
30	2, 5	ESS1.B		
31	2, 3, 5	ESS1.B	3	
32	2, 5	ESS1.B	3	HS-ESS1-4
33	2, 3, 5	ESS1.B	3	
34 - 35	2, 5	ESS1.B	3	HS-ESS1-4
36	2, 5	ESS1.B	3	
37	2, 3, 5	ESS1.B	3	
38	2, 5	ESS1.B	2, 7	
39	2	ESS1.B	2, 7	
40	2			
42	2	ESS1.B	3	HS-ESS1-4

4: THE HISTORY OF PLANET EARTH

Activity	SEP	DCI	CCC	PE
44		ESS1.C ESS2.B	1, 7	
45	6, 7	ESS1.C ESS2.B	1, 7	
46	2, 7	ESS1.C PS1.C	1, 7	
47	2, 3, 6, 7	ESS1.C PS1.C	1, 7	HS-ESS1-5, HS-ESS1-6
48	6, 7	ESS1.C	7	
49	6, 7	ESS1.C	1, 7	
50	6, 7	ESS1.C	1, 7	
53	6, 7	ESS1.C	1, 7	HS-ESS1-5

5: EARTH MATERIALS AND SYSTEMS

Activity	SEP	DCI	CCC	PE
55	2	ESS2.A	5	
56	2, 4	ESS2.A		
57	2	ESS2.A	5	
58	2	ESS2.A	2, 7	HS-ESS2-1
59	2	ESS2.A	2, 7	
60	2, 3, 4	ESS2.A	5, 7	HS-ESS2-2
61	2	ESS2.A	7	
62	2	ESS2.A	2, 7	
63	4	ESS2.A	2, 7	
64	2,4	ESS2.A	2, 7	
65	4	ESS2.A	2, 7	
67	2	ESS2.A ESS2.D	2	HS-ESS2-4



6: PLATE TECTONICS

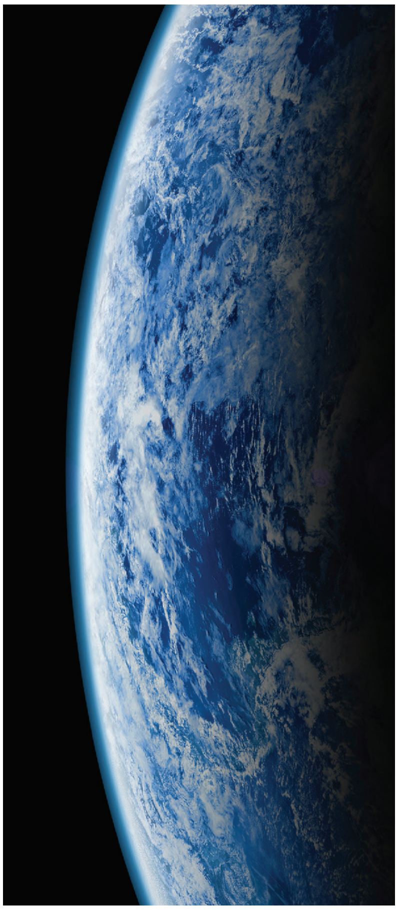
Activity	SEP	DCI	CCC	PE
69	2	ESS2.A ESS2.B	5	
70 - 71	2, 4	ESS2.A	5	
72	2	ESS2.B	5	
73	2, 3	ESS2.A	7	
74	2	ESS2.A ESS2.B	2	HS-ESS2-3
75	2	ESS2.A ESS2.B	2	HS-ESS2-3

7: THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES

Activity	SEP	DCI	CCC	PE
77 - 78	2, 6	ESS2.C	6	
79	2, 3	ESS2.C	6	HS-ESS2-5
80	2, 4	ESS2.C	6	
81	2	ESS2.C	6	
82	1, 2, 3	ESS2.C	6	HS-ESS2-5
83	1, 2, 3	ESS2.C	6	HS-ESS2-5
84	4	ESS2.C	6	
85	2	ESS2.C	6	
86	2, 4	ESS2.C	6	

8: WEATHER, CLIMATE, AND BIOGEOLOGY

Activity	SEP	DCI	CCC	PE
88	2	ESS2.D	2	HS-ESS2-4
89	2, 3	ESS1.B ESS2.A ESS2.D	2	HS-ESS2-4
90	2	ESS2.A ESS2.D	2	
91	2	ESS1.B ESS2.A ESS2.D	2	HS-ESS2-4
92	2, 7	ESS2.D ESS2.E	7	HS-ESS2-7
93	2, 7	ESS2.D ESS2.E	7	HS-ESS2-7
94	2, 7	ESS2.D ESS2.E	7	HS-ESS2-7
95	2, 7	ESS2.D ESS2.E	7	HS-ESS2-7
96	7	ESS2.E	7	HS-ESS2-7
97	7	ESS2.E	7	
98	2	ESS2.D	5	HS-ESS2-6
99	2, 3	ESS2.D	5	HS-ESS2-6
100	2	ESS2.D	5	
101	2, 7	ESS2.A ESS2.D	2, 5, 7	
102	2, 7	ESS2.D ESS2E	5, 7	HS-ESS2-6, HS-ESS2-7



9: NATURAL RESOURCES

Activity	SEP	DCI	CCC	PE
103	6			
104	6	ESS3.A	2	
105	2, 6	ESS3.A	2	HS-ESS3-1
106	4, 6	ESS3.A		
107	2, 6	ESS3.A	2	
108	6, 7	ESS3.A ETS1.B	2	HS-ESS3-1, HS-ESS3-2
109	7	ESS3.A ETS1.B		HS-ESS3-2
110	2, 6	ESS3.C ETS1.B	2	HS-ESS3-2
111	2, 4, 7	ESS3.A ETS1.B		HS-ESS3-2
112	2, 7	ESS3.A ETS1.B		HS-ESS3-2
113	2, 7	ESS3.A ETS1.B	2	HS-ESS3-2
114	7	ESS3.A ETS1.B		HS-ESS3-2
115	2, 3, 4, 7	ESS3.A ETS1.B	2	
116	4, 7	ESS3.A ETS1.B	2	HS-ESS3-2
117	7	ESS3.A	2	
118	2, 4, 7	ESS3.A ETS1.B	2	
119	2, 7	ESS3.A ETS1.B		HS-ESS3-2
120	7	ESS3.A ETS1.B		
121	2, 6, 7	ESS3.A ETS1.B	2	HS-ESS3-1, HS-ESS3-2

10: NATURAL HAZARDS

Activity	SEP	DCI	CCC	PE
123 - 125	2, 6	ESS3.A ESS3.B	7	
126 - 127	6	ESS3.A ESS3.B	7	HS-ESS3-1
128	4, 6	ESS3.A ESS3.B	7	
129	2, 4, 6	ESS3.A ESS3.B	7	HS-ESS3-1
130	6	ESS3.A ESS3.B	7	HS-ESS3-1
131	4, 6	ESS3.A ESS3.B	7	HS-ESS3-1

11: HUMAN IMPACTS ON EARTH SYSTEMS

Activity	SEP	DCI	CCC	PE
133	5, 7	ESS3.C	7	HS-ESS3-3
134	4, 5	ESS3.C	7	
135	1	ESS3.C	7	
136	2, 4, 6	ESS3.C ETS1.B	7	HS-ESS3-4
137	2, 6	ESS3.C ETS1.B	7	HS-ESS3-4
138	2, 6	ESS3.C ETS1.B	7	HS-ESS3-4
139	1, 2	ESS3.C	7	
140	2, 6	ESS3.C ETS1.B	7	HS-ESS3-4
141	4, 5	ESS3.C	7	
142	6	ESS3.C	7	
143	2	ESS3.C ETS1.B	7	
144	2, 6	ESS3.C ETS1.B	7	HS-ESS3-4
146	2, 5	ESS3.C	7	HS-ESS3-3

12: GLOBAL CLIMATE CHANGE

Activity	SEP	DCI	CCC	PE
148	1	ESS2.D ESS3.D	4, 7	
149	2	ESS2.D ESS3.D	4, 7	
150	2,4	ESS2.D ESS3.D	4, 7	HS-ESS3-5
151	2, 3, 4, 5	ESS2.D ESS3.D	4, 7	HS-ESS3-6
152	2, 4	ESS2.D	7	
153	4	ESS2.D ESS3.D	7	
154	2, 4, 6	ESS3.C ETS1.B	7	
156	4, 5	ESS2.D ESS3.D	4, 7	HS-ESS3-5, HS-ESS3-6

Identifying Common Core State Standards Connections

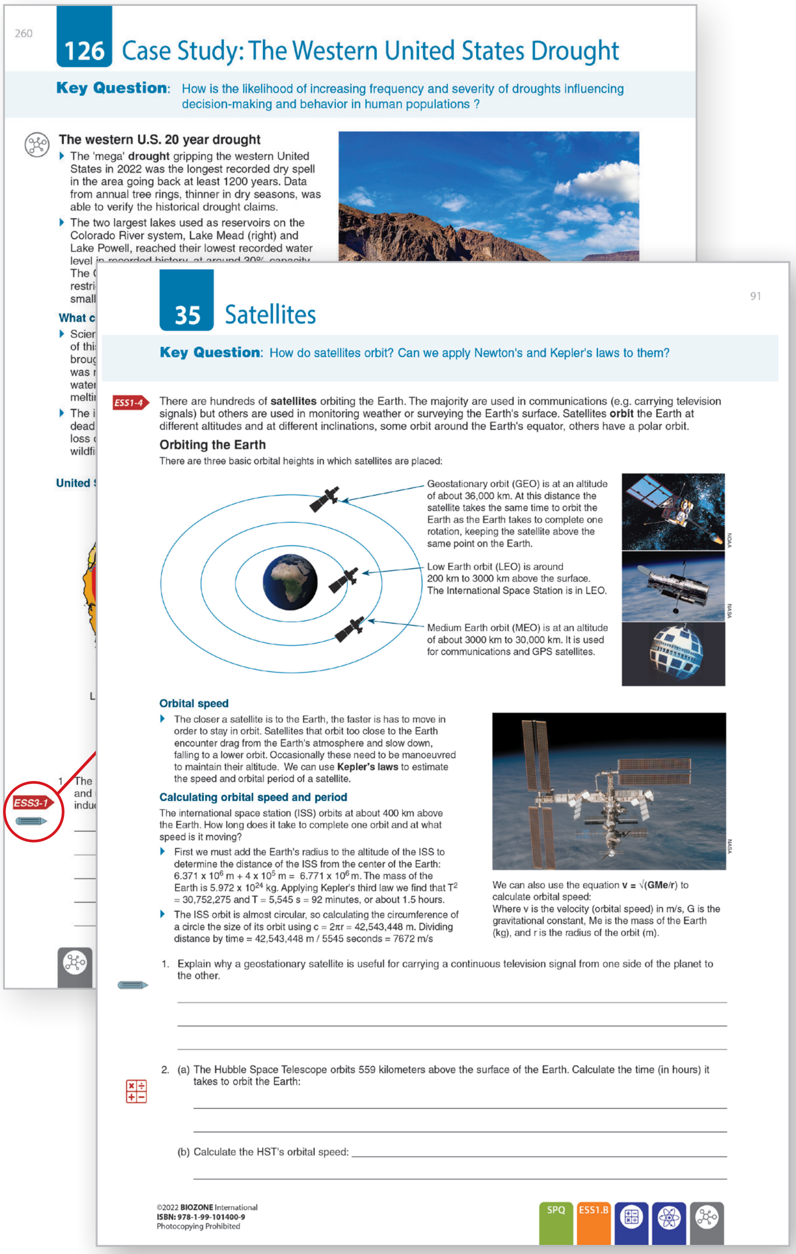
The activities in *Earth and Space Sciences for NGSS* provide many opportunities to address the **Common Core State Standards** (CCSS) for numeracy, and literacy, and English language development (ELD). The incorporation of these standards allows students to practice and develop these key skills while exploring science.

Activities incorporating representative citations of the CCSS Math Connections, ELA/ literacy, and ELD Connections specified in the NGSS Science Framework are identified by codes (right) in the **Teacher's Edition** and **Teacher's Digital Edition**. Note that this coding is a tool for the teacher and is not present in the Student Edition.

- A red calculator indicates a math connection.
- A blue pencil indicates an ELA/literacy or ELD connection.

A list of the specific Math Connections, ELA/ Literacy Connections and ELD Standards addressed in the NGSS framework can be found in the tables at the bottom of this page and on the following pages.

BIOZONE recognizes that ELD Standards are not to be used in isolation, and are intended to be implemented in conjunction with ELA/Literacy and other academic content standards. This is why you will see them appearing along with the relevant ELA/literacy connection in the following tables.


260

126 Case Study: The Western United States Drought

Key Question: How is the likelihood of increasing frequency and severity of droughts influencing decision-making and behavior in human populations ?

The western U.S. 20 year drought

- The 'mega' **drought** gripping the western United States in 2022 was the longest recorded dry spell in the area going back at least 1200 years. Data from annual tree rings, thinner in dry seasons, was able to verify the historical drought claims.
- The two largest lakes used as reservoirs on the Colorado River system, Lake Mead (right) and Lake Powell, reached their lowest recorded water level in recorded history, at around 30% capacity.

ESS3-1

91

35 Satellites

Key Question: How do satellites orbit? Can we apply Newton's and Kepler's laws to them?

ESS1-4 There are hundreds of **satellites** orbiting the Earth. The majority are used in communications (e.g. carrying television signals) but others are used in monitoring weather or surveying the Earth's surface. Satellites **orbit** the Earth at different altitudes and at different inclinations, some orbit around the Earth's equator, others have a polar orbit.

Orbiting the Earth

There are three basic orbital heights in which satellites are placed:

Orbital speed

- The closer a satellite is to the Earth, the faster is has to move in order to stay in orbit. Satellites that orbit too close to the Earth encounter drag from the Earth's atmosphere and slow down, falling to a lower orbit. Occasionally these need to be manoeuvred to maintain their altitude. We can use **Kepler's laws** to estimate the speed and orbital period of a satellite.

Calculating orbital speed and period

The international space station (ISS) orbits at about 400 km above the Earth. How long does it take to complete one orbit and at what speed is it moving?

- First we must add the Earth's radius to the altitude of the ISS to determine the distance of the ISS from the center of the Earth: 6.371×10^6 m + 4×10^5 m = 6.771×10^6 m. The mass of the Earth is 5.972×10^{24} kg. Applying Kepler's third law we find that T^2 = 30,752,275 and T = 5,545 s = 92 minutes, or about 1.5 hours.
- The ISS orbit is almost circular, so calculating the circumference of a circle the size of its orbit using $c = 2\pi r$ = 42,543,448 m. Dividing distance by time = 42,543,448 m / 5545 seconds = 7672 m/s

We can also use the equation **v = √(GMe/r)** to calculate orbital speed:
Where v is the velocity (orbital speed) in m/s, G is the gravitational constant, Me is the mass of the Earth (kg), and r is the radius of the orbit (m).

1. Explain why a geostationary satellite is useful for carrying a continuous television signal from one side of the planet to the other.

2. (a) The Hubble Space Telescope orbits 559 kilometers above the surface of the Earth. Calculate the time (in hours) it takes to orbit the Earth:

(b) Calculate the HST's orbital speed:

ISBN: 978-1-99-101400-9

SPQ ESS1.B

1: SCIENCE PRACTICES

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
3	Mathematics and Computation	MP2, HSN-Q.A.1, HSN.Q.A.2, HSN-Q.A.3	
4	Useful Concepts	MP4, HSN.Q.A.1, HSA-CED.A.4	
6-8	Tables, Graphs,Interpreting Data	MP4, HSN.Q.A.1	
9	Descriptive Statistics	MP4, HSN.Q.A.1, HSS.ID.A.1	
10	Planning an Investigation	MP4, HSN.Q.A.1, HSS.ID.A.1	SL.11-12.1.B, RST.11-12.3

2: THE UNIVERSE AND ITS STARS

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
13	Studying Stars	MP2, MP4, HSA-CED.A.4	RST.11-12.1, WHST.11-12.9
14	The Known Universe	MP2	SL.11-12.1, RST.11-12.2
17	Modelling Expansion of Universe	MP4, HSA-CED.A.4	SL.11-12.1.B, RST.11-12.3
18	The Sun	MP2, MP4, HSN.Q.A.1, HSA-CED.A.4,	SL.11-12.1.B, RST.11-12.3, WHST.11-12.9
24	Nucleosynthesis		SL.11-12.4, WHST.11-12.7
26	Summing Up	MP4	RST.11-12.2, RST.11-12.3, WHST.11-12.1

3: EARTH AND THE SOLAR SYSTEM

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
28	Exploring the Solar System		RST.11-12.2
29	Formation of the Solar System	MP4, HSN.Q.A.1, HSA-CED.A.4	
30	The Solar System	MP2, MP4, HSN.Q.A.1, HSS.ID.A.1	RST.11-12.4
31	The Motion of Celestial Objects	MP4	SL.11-12.1.B, RST.11-12.3
32	Kepler's Laws and Orbits	MP.2, MP.4, HSA-CED.A.4, HSN-Q.A.1,	RST.11-12.4
33	Gravity and Newton's Laws	MP4, HSA-SSE.A.1	SL.11-12.1.B, RST.11-12.3
34	Newton's Laws to Kepler's Laws	HSA.SSE.A.1.A, HSA-CED.A.4	RST.11-12.7
35	Satellites	HSA.SSE.A.1.A, HSA-CED.A.4	
36	The Orbit of Halley's Comet	MP.2, MP.4, HSA-CED.A.4, HSN-Q.A.1,	
37	Moving Planets	MP4, HSA-CED.A.4, HSA.SSE.A.1.A	SL.11-12.1.B, RST.11-12.3

4: THE HISTORY OF PLANET EARTH

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
46	Dating the Earth		RST.11-12.2, WHST.11-12.1
47	Evidence for the Age of the Earth	MP2, MP4, HSS-ID.B.6.C, HSN.Q.A.1,	SL.11-12.1.B, RST.11-12.3, WHST.11-12.1
50	The Earth's History		RST.11-12.4
52	Review Your Understanding	HSA-CED.A.4	
53	Summing Up	MP4	RST.11-12.1, RST.11-12.4, WHST.11-12.1

5: EARTH MATERIALS AND SYSTEMS

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
56	Evidence for Earth's Structure	MP4, HSN.Q.A.1, HSS.ID.A.1	
58	Factors That Shape the Earth		RST.11-12.4, RST.11-12.5
60	Ice Sheet Melting	MP4, HSN.Q.A.1	SL.11-12.1.B, RST.11-12.3
64	Short-Term Changes to the Earth	MP4	RST.11-12.2, WHST.11-12.9
67	Summing Up	MP4	

6: PLATE TECTONICS

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
70	The Heat of the Earth	MP4, HSN.Q.A.1	RST.11-12.3
71	Plate Tectonics	MP2, HSS.ID.A.1, HSN.Q.A.1, HSN.Q.A.3	SL.11-12.1, RST.11-12.1
72	Plate Boundaries		RST.11-12.2
73	Modeling Continental Drift	MP4, HSN.Q.A.1,	SL.11-12.1.B, RST.11-12.3
74	Review Your Understanding		RST.11-12.1, RST.11-12.2, WHST.11-12.1, WHST.11-12.9
75	Summing Up	MP4, HSN.Q.A.1, HSS.ID.A.1	

7: THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
79	The Rock Cycle		SL.11-12.1.B, RST.11-12.3
80	Water's Role in Melting of Rocks	MP4, HSN.Q.A.1	
81	Weathering and Erosion		RST.11-12.2, RST.11-12.5,
82	Investigating Frost Wedging		SL.11-12.1.B, RST.11-12.3
83	Modeling Erosion		SL.11-12.1.B, RST.11-12.3
84	Moisture Content and Soil Erosion	MP4, HSN.Q.A.1	
85	Review Your Understanding		RST.11-12.2, RST.11-12.4
86	Summing Up	HSN.Q.A.1, MP4	

8: WEATHER, CLIMATE, AND BIOGEOLOGY

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
88	Energy From the Sun	MP2, HSN.Q.A.1, HSN.Q.A.3	RST.11-12.1, WHST.11-12.9
89	Seasons		SL.11-12.1.B, RST.11-12.3
98	Carbon Cycling		RST.11-12.2, RST.11-12.4
99	Modeling the Carbon Cycle	MP2, HSN.Q.A.1, HSN.Q.A.2	SL.11-12.1.B, RST.11-12.3, WHST.11-12.2, WHST.11-12.7
100	Atmospheric Changes		RST.11-12.1, WHST.11-12.9
101	Review Your Understanding		RST.11-12.2, WHST.11-12.9
102	Summing Up	MP4	RST.11-12.2

9: NATURAL RESOURCES

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
105-106	Resources; Energy, Technology		RST.11-12.1,
110	Environmental - Oil Extraction		SL.11-12.1, WHST.11-12.1
111-114	Oil, Gas, Coal, Agriculture		RST.11-12.2, WHST.11-12.1,
115	Soil Management	MP4, HSN.Q.A.2	SL.11-12.1.B, RST.11-12.3,
116	Soils, Agriculture, and Solutions		SL.11-12.1.B, WHST.11-12.1
119	Living with Limited Resources	MP4 , HSN.Q.A.2, HSN.Q.A.3	RST.11-12.1, WHST.11-12.1
120	Review Your Understanding		WHST.11-12.1, WHST.11-12.7
121	Summing Up	MP4, HSN.Q.A.1, HSN.Q.A.2	RST.11-12.1, WHST.11-12.1,

10: NATURAL HAZARDS

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
125	Natural Hazards and Migration	MP4	RST.11-12.4, WHST.11-12.9
126	Case Study: The Western United States Drought		RST.11-12.7, WHST.11-12.9,
128	Wildfires	MP4	RST.11-12.1, RST.11-12.4
129	Flooding	MP4	RST.11-12.4, WHST.11-12.9
130	Review Your Understanding		RST.11-12.1, WHST.11-12.9
131	Summing Up	MP4	WHST.11-12.1, RST.11-12.2

11: HUMAN IMPACTS ON EARTH SYSTEMS

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
134	Human Sustainability	MP2, HSA.CED.A.1, HSN.Q.A.1, HSN.Q.A.2	RST.11-12.4
136	Fishing and Sustainability		RST.11-12.4, WHST.11-12.9
138	The Problem With Oil	MP4,	RST.11-12.2, WHST.11-12.9
140	Deforestation		RST.11-12.7, WHST.11-12.7
141	The Availability of Land	MP2, HSN.Q.A.1	
144	Evaluating Technological Solutions		RST.11-12.7, WHST.11-12.7
146	Summing Up	MP2, HSN.Q.A.1, HSN.Q.A.2	RST.11-12.4

12: GLOBAL CLIMATE CHANGE

Activity number	Activity	CCSS Math connection	CCSS ELA/Literacy & ELD connection
149	The History of Climate Modeling		SL.11-12.1, WHST.11-12.9
150	Models of Climate Change	MP4, HSN.Q.A.2	RST.11-12.4, RST.11-12.8,
151	Ocean Acidification	MP4, HSN.Q.A.2	SL.11-12.1.B, RST.11-12.3
154	Tech Solutions to Climate Change	MP2	RST.11-12.2, WHST.11-12.9,
155	Review Your Understanding		WHST.11-12.1, WHST.11-12.7
156	Summing Up	MP2, MP4, HSN.Q.A.1	RST.11-12.4