Earth Systems

GeoBox

link™
CPO Science

Real Investigations in
Science and Engineering

Overview Chart for Investigations–GeoBox

	Investigation	Key Question	Summary	Learning Goals	Vocabulary
A1	**Heating and Cooling Land and Water** Pages 1–6 100 minutes	How does solar radiation affect the heating and cooling of continents and oceans?	Students will use two GeoBoxes to see what happens when sand and water are heated and cooled. After exposing both sand and water to a light source and taking periodic temperature readings, students will explain their results using the concept of specific heat.	• Measure temperature changes in sand and water. • Use the idea of specific heat to analyze temperature data. • Compare geographic regions according to temperature ranges and presence of large bodies of water.	specific heat
A2	**Wave Speed** Pages 7–14 50 minutes	What is the relationship between water depth and wave speed?	Students will learn about waves and find out that most waves in the ocean and on large lakes are driven by the wind. Students explore the relationship between water depth and wave speed using the GeoBox. They then apply what they learn to explain what happens as waves approach a shoreline.	• Predict the relationship between wave depth and speed. • Measure the distance a wave travels, time the wave, and calculate the wave speed ($v = d/t$). • Graph results.	crest trough wave wavelength
A3	**Floating and Sinking: Salinity** Pages 15–22 100 minutes	Do things float differently in salt water than they do in fresh water?	Students think about their experiences with salt water as compared to fresh water. They learn that salinity is a measure of the dissolved salts in water. Students investigate a basic difference between fresh water and salt water related to whether objects float.	• Determine that things float more easily in salt water than they do in fresh water. • Explain that the higher density of salt water helps things float more easily in salt water than fresh water. • Describe how density differences in ocean water drive deep ocean currents.	deep ocean currents density salinity salt marsh
A4	**Convection in Liquids** Pages 23–28 50 minutes	What happens when there are temperature differences in a container of water?	Students learn that convection is the transfer of heat through the motion of gases and liquids such as air and water due to density differences. They learn that convection is what causes wind to blow in the atmosphere and currents to flow in the ocean. Students use the water-filled GeoBox and small containers of hot and cold water to demonstrate convection.	• Define convection and explain how it works. • Explain how convection creates weather patterns and ocean currents. • Give an everyday example of convection at work in your home or classroom.	convection density
A5	**Topographic Maps** Pages 29–36 50 minutes	How does a two-dimensional map represent a three-dimensional landform?	This investigation uses the GeoBox and landform A to plot a simple topographic map. The GeoBox lid is used to draw contour lines that represent the shape of the landform.	• Understand the meaning of topography and why it is important to document on a map. • Learn how contour lines are used to show a 3-D landform in two dimensions. • Create a topographic map of a landform.	contour interval contour lines topographic map topography

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A6	**More Topographic Maps** Pages 37–44 50 minutes	How does land change over 10 million years?	Students observe and compare landforms A and B and describe how land changes over millions of years. They also learn about weathering and erosion, the earth processes that caused many of the changes in the landforms. Students then document the changes by making a topographic map of landform B to compare to the map they made of landform A in Investigation A5.	• Observe how a landform can change over 10 million years. • Identify how changes in a landform over time can be documented by a topographic map. • Observe the effects of weathering and erosion.	erosion weathering
A7	**Predicting How Land Changes** Pages 45–52 50 minutes	How does a volcano change over time?	Students research volcanoes and look at photographs of volcanoes to develop a prediction for what the topo form will look like in 10 million years. Finally, they build a model of their prediction using foam board.	• Learn about the types of volcanoes and how they form. • Create a model of a landscape using a topographic map and foam board. • Use research to predict how a volcanic landscape will look in 10 million years.	caldera cinder cone composite volcano erosion igneous rock shield volcano volcano weathering
A8	**Human Activities and Erosion** Pages 53–62 50 minutes	How do objects and structures affect erosion?	Students learn about coastal erosion as a natural process that is exacerbated by storms and hurricanes. They model how structures such as breakwaters, seawalls, and homes impact coastal areas. They consider the issues surrounding building in coastal areas and the damage caused by severe storms.	• Use the GeoBox to test and describe the effects of coastal erosion. • List the pros and cons associated with hard erosion control structures, such as breakwaters and seawalls. • Discuss how coastal construction influences erosion and whether building in coastal areas should be restricted.	breakwater erosion seawall
B1	**Floating and Sinking: Density** Pages 63–68 50 minutes	Why do steel boats float when steel is denser than water?	Students learn how to determine whether an object will sink or float. They then extrapolate their learning to explain how a steel ship floats in water. They demonstrate how this is possible using clay, and learn about the difference between a material's density and an object's average density.	• Collect data to find density and average density. • Figure out how to make clay, which is denser than water, float. • Explore boat design and engineering.	average density density

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B2	**Convection in Earth's Atmosphere** Pages 69–76 50 minutes	How is convection responsible for the movement of air through the atmosphere?	Using the GeoBox as a convection chamber, students explore how convection currents move air from one place to another and how they produce winds.	• Describe what happens to air when it is warmed (e.g., by a candle or Earth's warmed surface). • Explain how heat transfer by convection takes place. • Explain how convection currents cause air to move from one place to another in the atmosphere.	convection
B3	**Topographic Mapping** Pages 77–82 50 minutes	How does changing the landform change the topographic map?	Students alter the topo form and create a new map. In the process, they see how landforms are represented on a topographic map with contour lines. After creating a new landscape and mapping it, they will be asked to match the maps to the corresponding forms.	• Create a unique topo form and its corresponding topographic map. • Interpret different topographic maps and match to the correct topo form. • Describe how different topographic features are represented on a topographic map.	topographic map topography
B4	**Topographic Mapping and River Valleys** Pages 83–88 50 minutes	What does a river valley look like on a topographic map?	In this investigation, students use clay to transform landform A into a river valley. Then, they create a topographic map of the altered landform.	• Create a unique river valley landform and its corresponding topographic map. • Evaluate how a river valley is represented on a topographic map with contour lines. • Review water erosion and the structure of river valleys.	river valley
B5	**Floods and Wetlands** Pages 89–94 50–100 minutes	How do wetlands act as flood and pollution control systems?	Students learn that flooding commonly occurs when heavy rain or snowmelt adds more water to a river than it can carry. Data for a California river are presented on a graph with two *y*-axes. Students learn how to interpret the graph. Next, students model why wetlands are important for preventing flooding and blocking pollution.	• Compare and contrast accumulated precipitation with river stage levels before, during, and after a flood event. • Understand the dynamic role of wetlands as flood controllers and filtration systems.	accumulated precipitation river stage wetland
B6	**Groundwater and Pollutants** Pages 95–100 100 minutes	How do human activities impact groundwater?	In the investigation, students model an aquifer and how groundwater (and pollutants) flow into an aquifer. They consider the importance of the structures of aquifers, aquitards, and aquicludes.	• Understand the process of how water collects underground and serves as a resource for people. • Model the movement of groundwater into an aquifer. • Recognize the impact of pollution on groundwater.	aquiclude aquifer aquitard groundwater water table

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B7	**Engineering and the Water Cycle** Pages 101–108 100+ minutes	Is it possible to transform ocean water into drinkable fresh water?	Students learn about the water cycle and its importance. They will model three of its processes by demonstrating how ocean water can be transformed into fresh water. They will then devise an experiment to test the salinity of the water they collect. Finally, students will design a device for collecting 1 gallon of fresh water a day.	• Make a 3.5% salt water solution. • Set up a working model of the water cycle. • Design an experiment to detect salt in a water sample and design a device that could produce a gallon of fresh water per day.	condensation desalination evaporation salinity water cycle
C1	**Floating and Sinking: Buoyancy** Pages 109–116 50 or 100 minutes	How does Archimedes' principle work?	Students will learn how Archimedes' principle applies to things that float. The weight of displaced water, or buoyant force, is the key factor. After they apply Archimedes' principle to their clay boats, they apply the science to a floating watertight container.	• Define and explain Archimedes' principle. • Draw free-body diagrams for objects that float and sink. • Apply Archimedes' principle to solve a problem.	Archimedes' principle buoyant force
C2	**Predicting Erosion with Satellite Images and a Map** Pages 117–124 50 or 100 minutes	What kinds of information do satellite images and topographic maps provide?	Students study and interpret topographic maps and satellite images. They learn that satellite images can be used to construct topographic maps of an area, as well as to view the vegetation or structures covering the land. Students use the images and map to predict areas of erosion and decide how erosion might be prevented or reduced.	• Interpret land features in topographical maps and satellite images. • Identify areas that are prone to erosion. • Suggest ways to reduce or prevent erosion of landforms and damage to structures.	contour interval contour lines erosion meander topographic map

Next Generation Science Standards Correlation

CPO Science *Link* investigations are designed for successful implementation of the Next Generation Science Standards. The following chart shows the NGSS Performance Expectations and dimensions that align to the investigations in this title.

NGSS Performance Expectations	GeoBox Investigations
MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.	A5, A6, A7, B3, B4
MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.	B7
MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.	B6
MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.	A8
MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	A1, A4, B2
HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	A3, B5, C1, C2
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	B1
HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	A2

Next Generation Science Standards Correlation (cont'd)

NGSS Science and Engineering Practices	GeoBox Investigations
Analyzing and Interpreting Data	A1, A3, A8
Constructing Explanations and Designing Solutions	B1, B6
Developing and Using Models	A4, A5, A6, A7, B2, B3, B4, B5, B7, C2
Obtaining, Evaluating, and Communicating Information	C2
Patterns	B3
Planning and Carrying Out Investigations	C1
Using Mathematics and Computational Thinking	A2, C1

NGSS Disciplinary Core Ideas	GeoBox Investigations
ESS2A: Earth Materials and Systems	A1, B7
ESS2C: The Role of Water in Earth's Surface Processes	A3, A4, A5, A6, A7, A8, B3, B4, B5, C2
ESS3.A: Natural Resources	B6
ESS3C: Human Impacts on Earth Systems	A8, C2
ETS1B: Developing Possible Solutions	B1
ETS1C: Optimizing the Design Solution	B1
PS1A: Structure and Properties of Matter	A4, B2, C1
PS4.A: Wave Properties	A2

NGSS Crosscutting Concepts	GeoBox Investigations
Cause and Effect	A1, A2, A4, A7, A8, B5, B6, C2
Energy and Matter	A1, A3, B2, C1
Influence of Engineering, Technology, and Science on Society and the Natural World	B6
Interdependence of Science, Engineering, and Technology	B1
Scale, Proportion, and Quantity	A5, A6, B3, B4
Stability and Change	A7, A8, C2
Systems and System Models	A4, B2, B5, B7

Common Core State Standards Correlation

CCSS-Mathematics		GeoBox Investigations
MP.2	Reason abstractly and quantitatively.	A2, A5, A6, A7, A8, B3, B4
MP.4	Model with mathematics.	A2, B1
6.RP.A.1	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.	A2
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems.	A2
6.NS.C.5	Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.	A1, A4, B2
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.	A5, A6, A7, A8, B3, B4, B6
7.RP.A.2	Recognize and represent proportional relationships between quantities.	A2, B7
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.	A5, A6, A7, A8, B3, B4, B6
8.F.A.3	Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear.	A2
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	A3, B5, C1, C2

CCSS-English Language Arts & Literacy		GeoBox Investigations
RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts.	A5, A6, A7, A8, B3, B4, B6
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).	A1, A4, A8, B2, B7
WHST.6-8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.	A5, A6, A7, B3, B4, B6
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research.	B6
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	A3, B5, C1, C2