

CATASTROPHIC EVENTS CURRICULUM



Grade Level(s): 11-12

Curriculum Author(s): Melissa Hodges

Course Description: This is a lab-based course that focuses on the causes and hazards associated with profound catastrophic events that impact humanity. The curriculum will explore topics such as hurricanes, earthquakes, volcanoes, tsunamis, global epidemics, radiation exposure, and major air pollution events including climate change. Students can study the nature, causes, and impacts of these events. They will apply science and engineering practices to explore solutions that may help to reduce environmental effects. Students will also investigate our universe's first catastrophic event, the Big Bang.

Year At A Glance

Unit Title	Overarching Essential Question	Overarching Enduring Understanding	<u>Vision of A Learner “I Can” Statements</u>
<u>The Dynamic Earth</u> (6 weeks)	What are the effects of earthquakes and volcanoes?	Land masses are moving slowly across our planet's surface. The atmosphere is a swirling mix of gasses and vapor. Our planet, which may appear placid from space, is not stable and unchanging.	TCC1(9-12); TCC2(9-12); TI1(9-12); AA2(9-12)
<u>Aquatic Ecosystems</u> (5 weeks)	How do aquatic ecosystems function?	Water is of vital importance to the survival of all ecosystems.	TCC1(9-12); TCC2(9-12); TI1(9-12); AA2(9-12)
<u>Biodiversity</u> (5 weeks)	How much extinction is natural, how are humans impacting it, and should we prevent it?	Everyday somewhere on Earth, a unique species of organism becomes extinct, often because of human actions, which can have long range effects on ecosystems.	TCC1(9-12); TCC2(9-12); TI1(9-12); AA2(9-12)
<u>The Big Bang</u> (3 weeks)	How did our universe begin and how have we learned about its composition?	The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gasses, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.	TCC1(9-12)



Unit 1 - The Dynamic Earth

Desired Results - Students will understand the composition of the Earth and how the geosphere, atmosphere, hydrosphere and biosphere interact with each other.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

NGSS Standards:

HS-ESS1-5 - Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS2-1 - Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

HS-ESS2-3 - Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

HS-ESS2-5 - Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

HS-ESS2-7 - Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

HS-ESS3-1 - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS2-4 - Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Vision of A Learner Attributes: Students will be able to independently use their learning to ask purposeful, insightful questions to find a variety of innovative solutions.

- TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.
- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- AA2(9-12): I can assess my past successes and mistakes to change my approach.



Understandings: Students will understand that...

- The mixture of gasses that surrounds the Earth is called the atmosphere.
- The atmosphere is composed almost entirely of nitrogen and oxygen and is divided into four layers based on changes in temperature that take place at different altitudes.
- Heat is transferred in the atmosphere through radiation, conduction, and convection.
- Earth's surface is broken into pieces called tectonic plates, which collide, separate or slip past one another.
- earthquakes . volcanic eruptions, and mountain building are all events that occur at the boundaries of tectonic plates.
- The hydrosphere includes all of the water at or near the Earth's surface.
- The ocean absorbs and stores energy from sunlight, regulating temperatures in the atmosphere.
- The biosphere is the narrow layer at the surface of the Earth where life can exist.
- Carbon cycles through cellular respiration in organisms and photosynthesis in plant life.

Essential Questions:

- What are the main causes of earthquakes?
- What are the effects of earthquakes?
- What effects do large scale volcanic eruptions have on the global climate?
- How do wind and water alter the Earth's surface?
- What is the role of greenhouse gasses in the Earth's atmosphere?
- How does human activity change some greenhouse gas levels?
- How is the Earth's climate regulated by ocean temperatures?
- How can we relate the composition of rocks to the early composition of the Earth?
- How does carbon cycle through the various layers of the earth and atmosphere?
- What causes hurricanes?

Students will know...

- The composition and structure of the Earth.
- The relationship between volcanic eruptions and climate change.
- The three major processes in the water cycle.
- How the Himalayan Mountains formed.
- How the Richter scale works and what information it provides.
- The most abundant greenhouse gasses.

Students will be able to...

- Describe the Earth's tectonic plates.
- Explain the main cause of earthquakes and their effects.
- Describe how wind and water alter the Earth's surface.
- Describe the composition of the Earth's atmosphere.
- Describe the layers of the Earth's atmosphere.
- Explain three mechanisms of heat transfer in Earth's atmosphere.
- Explain the greenhouse effect.
- Describe the properties of ocean water.
- Describe the two types of ocean currents.
- Explain how the ocean regulates Earth's temperature.
- Discuss the factors that confine life to the biosphere.
- Explain the difference between open and closed systems.

Key Vocabulary: geosphere, crust, mantle, core, lithosphere, asthenosphere, tectonic plate, erosion, atmosphere, troposphere, stratosphere, ozone, radiation, conduction, convection, greenhouse effect, water cycle, evaporation, condensation, precipitation, salinity, fresh water, biosphere, closed system, open system, meteorite, carbon cycle, hurricane

Assessment Evidence

Performance Tasks:

- Shake, Rattle and Roll lab
- Unit Exam
- Volcano Project

Other Evidence:

- What are the effects of earthquakes article
- Intro to plate tectonics EdPuzzle
- Layers of the Atmosphere Graphs and Questions
- Active Reading: The Geosphere
- Atmosphere Webquest
- Hurricane Prediction: Tracking the Storm Activity
- Rock Cycle Gizmo
- Carbon Cycle Gizmo

Learning Plan

THINK CRITICALLY AND CREATIVELY

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

- Shake Rattle and Roll lab (Buildings that can withstand an earthquake)

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Volcano research project

TAKE INITIATIVE

TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.

- Test buildings and make adjustments during the Shake Rattle and Roll lab

ADAPT AND ADJUST

AA2(9-12): I can assess my past successes and mistakes to change my approach.

- Adjust building designs

Teacher Resources:

- Environmental Science Textbook Chapter 3
- Explorelearning.com GIZMOs



- <https://www.earthsciweek.org/classroom-activities>

Unit 2 - Aquatic Ecosystems

Desired Results - Students will understand the importance of water in the survival of ecosystems and how humans are impacting those ecosystems.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

NGSS Standards:

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-ESS3-1 - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.
- TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
- CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
- TI2(9-12): I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge.

Understandings: Students will understand that...

- Oil spilled at sea poses a serious threat to the marine

Essential Questions:

- How are the types of organisms determined in an aquatic



<p>environment.</p> <ul style="list-style-type: none"> • The plants and animals in aquatic ecosystems adapted to the specific environmental conditions. • Freshwater wetlands trap and filter sediment and pollutants; reduce the likelihood of floods; and buffer against shoreline erosion. • Estuaries are among the most productive of ecosystems because they constantly receive fresh nutrients from a river and from an ocean, which allows for a habitat for a multitude of plants and animals. • Coral reefs play a vital role in aquatic ecosystems because they provide habitat for approximately ¼ of all marine organisms. 	<p>ecosystem?</p> <ul style="list-style-type: none"> • What factors determine the types of organisms that live in lakes, ponds or oceans? • What causes most coastal pollution? • How do scientists categorize marshes? • How have oil spills affected our environment? • In what type of environments do coral reefs thrive in? • How is the government involved in preventing oil spills? • What causes tsunamis and how do those impact the environment?
<p>Students will know...</p> <ul style="list-style-type: none"> • The methods used to clean up oil spills include mechanical equipment, chemical agents and biological agents. • Biodegradation is a process by which microorganisms such as bacteria, fungi and yeasts break down complex compounds into simpler products. These are used to convert oil into food for themselves. • A tsunami is a set of ocean waves caused by any large or sudden disturbance of the sea's surface. • Aquatic ecosystems can be classified as freshwater or marine ecosystems. • Freshwater ecosystems include lakes, ponds, freshwater wetlands, rivers and streams. The types of freshwater ecosystems are classified by the depth of water, the speed of water flow, and the availability of minerals, sunlight, and oxygen. • Marine ecosystems are identified by the presence of salt water and include coastal wetlands, coral reefs, oceans and polar ecosystems. • Coral reefs are susceptible to destruction because they must remain at tropical temperatures and they must receive a large amount of sunlight. 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Describe the factors that determine where an organism lives in an aquatic ecosystem. • Describe the littoral zone and the benthic zone that make up a lake or pond. • Describe two environmental functions of wetlands. • Describe one threat against river ecosystems. • Explain why an estuary is a very productive ecosystem. • Compare salt marshes and mangrove swamps. • Describe two threats to coral reefs. • Describe two threats to ocean organisms.
<p>Key Vocabulary: wetland, plankton, nekton, benthos, littoral zone, benthic zone, eutrophication, estuary, salt marsh, mangrove swamp, barrier</p>	



island, coral reef, oil spill, biodegradation, tsunami

Assessment Evidence

Performance Tasks:

- Oil Eating Bacteria Lab
- Save the Chesapeake Bay
- Unit Exam

Other Evidence:

- The Cost of Oil Spills
- Tsunami activity/article
- Microteaching activity
- River Erosion Gizmo

Learning Plan

THINK CRITICALLY AND CREATIVELY

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Investigate the causes and effects of oil spills

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

- Save the Chesapeake Bay Activity

COLLABORATE AND COMMUNICATE EFFECTIVELY

CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.

- Oil Eating Bacteria Lab

TAKE INITIATIVE

TI2(9-12): I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge.

- Microteaching activity (design a quiz)

Teacher Resources:

- Environmental Science Textbook Chapter 7
- Explorelearning.com GIZMOs
- <https://www.earthsciweek.org/classroom-activities>



Unit 3 - Biodiversity

Desired Results - Students will understand that everyday somewhere on Earth, a unique species of organism becomes extinct, often because of human actions, which can have long range effects on ecosystems.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

NGSS Standards:

HS-ESS2-7 - Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

HS-LS4-4 - Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

HS-LS4-5 - Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ESS3-1 - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.
- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- AA2(9-12): I can assess my past successes and mistakes to change my approach.

Understandings: Students will understand that...

- Biodiversity refers to the number and variety of different species in a given area, as well as genetic variation within a population or across ecosystems.
- Humanity benefits from biodiversity in several known and unknown ways.
- The loss of biodiversity is one of the most challenging environmental issues we face.
- Most major conservation efforts now concentrate on protecting

Essential Questions:

- Why are some areas more susceptible to wildfires?
- How are humans impacting extinctions?
- What is the Endangered Species Act? What happens to those that violate it?
- What is the difference between an exotic species, threatened species and endangered species?
- Where are many critical biodiversity hotspots located?
- What is the primary cause of animal extinction?

entire ecosystems rather than individual species.	<ul style="list-style-type: none"> • What laws exist to protect animals from extinction?
<p>Students will know...</p> <ul style="list-style-type: none"> • Biodiversity is the study of identifying and cataloging all species on Earth. • The most common cause of extinction today is the destruction of habitats by humans. • Certain areas of the world contain a greater diversity of species than others. • The Endangered Species Act establishes protections for endangered and threatened species in the United States. 	<p>Students will be able to...</p> <ul style="list-style-type: none"> • Describe the diversity of species types on Earth, relating the difference between known numbers and estimated numbers. • List and describe the levels of biodiversity. • Explain four ways in which biodiversity is important to ecosystems and humans. • Analyze the potential value of a single species. • Define and give examples of endangered and threatened species. • Describe ways that species are being threatened with extinction globally. • Explain which types of threats are having the largest impact on biodiversity. • List areas of the world that have high levels of biodiversity and many threats to species. • Compare the amount of biodiversity in the United States to that of the rest of the world. • List and describe efforts to save individual species. • Explain the advantages of protecting entire ecosystems rather than individual species. • Describe the main provisions of the Endangered Species Act. • Discuss ways in which efforts to protect endangered species can lead to controversy. • Describe examples of worldwide cooperative efforts to prevent extinctions.
<p>Key Vocabulary: biodiversity, gene, keystone species, ecotourism, endangered species, threatened species, exotic species, poaching, endemic species, germ plasm, Endangered Species Act, habitat conservation plan, Biodiversity Treaty</p>	
<p>Assessment Evidence</p>	
<p>Performance Tasks:</p> <ul style="list-style-type: none"> • Biodiversity Group Activity • Unit Exam 	<p>Other Evidence:</p> <ul style="list-style-type: none"> • Why we Should Care Activity • Coral Reef Gizmos



- Hotspots Webquest
- California Wildfires activity
- Biomagnification Activity

Learning Plan

THINK CRITICALLY AND CREATIVELY

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Why we Should Care

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

- Why Does California Have So Many Wildfires?

COLLABORATE AND COMMUNICATE EFFECTIVELY

CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.

- Biodiversity Group Activity

TAKE INITIATIVE

TI2(9-12): I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge.

- Hotspots Webquest

Teacher Resources:

- Environmental Science Textbook Chapter 10
- Explorelearning.com GIZMOs
- <https://www.earthsciweek.org/classroom-activities>



Unit 4 - The Big Bang

Desired Results - Students will understand that The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gasses, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.

Established Goals:

Common Core State Standards:

RST.9-10.7 - Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words

RST.11-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes

NGSS Standards:

HS-ESS1-1 -Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun’s core to release energy that eventually reaches Earth in the form of radiation.

HS-ESS1-2 - Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

Understandings: Students will understand that...

- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.
- The Big Bang Theory is supported by studying distant galaxies.

Essential Questions:

- How did our universe begin?
- What is the composition of our universe?
- How do scientists know about the composition of the universe?

Students will know...

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.

Students will be able to...

- Explain the origins of our universe.
- Explain the Big Bang Theory.



Key Vocabulary: Big Bang, aquifer, Karst, groundwater, geologic heritage, solar flares, space weather, galaxy, interstellar gases, stars

Assessment Evidence

Performance Tasks:

- The Big Bang Theory Webquest/research
- Unit Exam

Other Evidence:

- Big Bang Theory Gizmo
- H-R Diagram Gizmo

Learning Plan

THINK CRITICALLY AND CREATIVELY

TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

- Big Bang Theory webquest

Teacher Resources:

<https://www.earthsciweek.org/classroom-activities/ngss>

<https://universe.nasa.gov/universe/basics/>

Explorelearning.com GIZMOs

