GEO-ENVIRONMENTAL SCIENCE

CURRICULUM

CARLISLE AREA SCHOOL DISTRICT

DATE OF BOARD APPROVAL: **January 19, 2023**

COURSE OVERVIEW

Title:	Geo-Environmental Science
Grade Level:	Grade 9
Level:	Option 1, Option 2, and Honors
Length:	Full Year
Duration:	85 Minute Periods
Frequency:	90 Days
Pre-Requisites:	None
Credit:	1 Credit
Description:	Geo-Environmental is a course dedicated to understanding the formation of our planet and the dynamic processes that occur on and within it, as well as interactions between the Earth's natural systems and the demands placed on them by the human population. This course examines the scientific principles behind natural phenomena and explores how we utilize these systems, our impact, and potential sustainable solutions. This course includes several simulated and hands-on laboratory experiences, as well as project-based learning experiences.

COURSE TIMELINE

UNIT	TITLE	KEY CONCEPTS	DURATION (DAYS)
1	Earth History	• Formation of the universe • Formation of the Earth and solar system • Relative and absolute dating • Index fossils and correlation • Geologic time scale	22 Days
2	Climatology	• Climate factors • Climate change - natural causes • Present day climate change causes • Climate change effects and solutions	22 Days
3	Resources and Sustainability	• Renewable and nonrenewable resources • Hydrologic systems • Human effects on the Earth's resources • Sustainability	22 Days
4	Tectonics	• Compositional and structural layers of the Earth • Continental drift and the theory of plate tectonics • Driving forces of tectonics (convection) • Plate boundaries and features associated with each • Earthquakes and volcanoes	22 Days

DISCIPLINARY SKILLS and PRACTICES

Science and Engineering Practices	DESCRIPTION
Asking questions and designing models	Ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and what can be empirically tested.
Developing and using models	Use and construct models as helpful tools for representing ideas and explanations.
Planning and carrying out investigations	Plan and carry out investigations in the field or laboratory, working collaboratively as well as individually.
Analyzing and interpreting data	Analyze data to identify the significant features and patterns in order to derive meaning.
Using mathematics and computational thinking	Represent physical variables and their relationships by constructing simulations, statistically analyzing data, and recognizing, expressing, and applying quantitative relationships.
Constructing explanations and designing solutions	Construct scientific explanations and/or produce an engineering outcome.
Engaging in argument from evidence	Engage in argument based in evidence to reach sound explanations and solutions.
Obtaining, evaluating and communicating information	Communicate clearly and persuasively the ideas and methods they generate.

Science and Engineering Practices derived from https://www.education.pa.gov/

PA- NGSS - Cross-Cutting Concepts	DESCRIPTION
Patterns	Identify observed patterns to prompt questions about relationships and the factors that influence them.
Cause and Effect	Investigate and explain causal relationships Based on the given relationships, predict and explain events in new contexts.
Scale, Proportion, and Quantity	Recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
Structure and Function	Understand how the form of an object or organism, determines many of its properties and functions.
Systems and System Models	Create models of a system to understand and/or test scientific ideas.
Matter and Energy	Track fluxes of energy and matter into, out of, and within systems to understand the systems' possibilities and limitations.
Stability and Change	Understand how conditions of stability, and determinants of rates of change or evolution of a system, are critical elements of study.

Crosscutting concepts derived from https://www.education.pa.gov/

UNIT 1

Unit Title	Earth History
Unit Description	Earth is a dynamic system, and all atmospheric, lithospheric, and hydrospheric processes interrelate and influence one another. The unit begins with the Big Bang as the formation of the Universe. Students will learn about the formation of the solar system to have a larger context for the Earth's place in the universe. Students will learn about the scale of the geologic timescale and create a model to depict the significant biologic, climatologic, and geologic changes throughout Earth history.
Unit Assessment	Summative and formative assessments centered on key content, concepts, and understandings.

Essential Question	**Learning Goals**	**Content and Vocabulary**	**Standards**
What is the evidence to support the Big Bang Theory? **3 Days**	☐ **Successful completion of safety training is mandatory for students within this course prior to participation in any laboratory experiments.** ☐ Explain how the nature of the Universe is evidence of the Big Bang Theory. ☐ Explain how studying light can help us understand the movement and composition of the universe and objects in space.	**Vocabulary:** electromagnetic spectrum, spectra, doppler effect, cosmic background radiation **Concepts:** -Big Bang Theory -expanding universe -stellar evolution	3.3.10.B1 Explain how gravity is responsible for planetary orbits. Explain what caused the sun, Earth, and most of the other planets to form between 4 and 5 billion years ago. Provide evidence to suggest the Big Bang Theory. Describe the basic nuclear processes involved in energy production in a star.

How did the solar system form? **3 Days**	☐ Understand the influence of gravity in the formation of the solar system and the Earth. ☐ Explain how the composition and movement of planets in the solar system provide evidence for the formation of the Earth. ☐ Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of the Earth's formation and early history.	**Vocabulary:** nebula, protostar, coalesce, accretion, gravity, fusion **Concepts:** -Solar Nebular Hypothesis -gravitational sorting	3.3.12.B1 Describe the life cycle of stars based on their mass. Analyze the influence of gravity on the formation and life cycles of galaxies, including our own Milky Way Galaxy; stars; planetary systems; and residual material left from the creation of the solar system. Relate the nuclear processes involved in energy production in stars and supernovas to their life cycles.
How do we measure age and time in the rock record using relative dating or absolute dating techniques? **5 Days**	☐ Use stratigraphic principles to construct a sequence of geologic events. ☐ Differentiate the various techniques for absolute dating and evaluate the merits of each strategy. ☐ 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.	**Vocabulary:** absolute, relative, stratigraphy, half-life, index fossils, correlation **Concepts:** -absolute and relative dating -radiometric dating -principles of stratigraphy	3.3.10.A3 Describe the absolute and relative dating methods used to measure geologic time, such as index fossils, radioactive dating, law of superposition, and crosscutting relationships.

Why and how do we break up geologic time into the eras and periods of the geologic timescale? **10 Days**	☐ Explain the basis for the divisions in the geologic timescale and describe why it is needed when learning about Earth's history. ☐ Describe some of the key events that have punctuated Earth's past. ☐ Create a model to demonstrate the scale and events of Earth history. ☐ 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.	**Vocabulary:** eon, era, period, epoch, mass extinction **Concepts:** -geologic time	3.3.10.A7 Apply an appropriate scale to illustrate major events throughout geologic time.

UNIT 2

Unit Title	Climatology
Unit Description	As Earth's climate changes, it is imperative to understand the systems involved in our climate. This unit will begin with a review of the relationships between the factors that cause or influence climate and how the climate has changed throughout Earth's history. Then, it will delve into the carbon cycle and anthropogenic causes and effects of modern-day climate change.
Unit Assessment	Summative and formative assessments centered on key content, concepts, and understandings.

Essential Question	**Learning Goals**	**Content and Vocabulary**	**Standards**
What are the natural factors that contribute to climate on a global and local scale? **10 Days**	☐ Differentiate between weather and climate. ☐ Describe how each factor influences the climate of a region on a global or local scale. ☐ Explain the relationship between the position of Earth in space, insolation, and the seasons. ☐ Describe how insolation drives global winds and oceanic patterns and how they impact the climate.	**Vocabulary:** climate, latitude, elevation, insolation, convection, thermohaline circulation, Hadley cells, albedo **Concepts:** -oceanic conveyor belt -rain shadow effect -proximity to water -differential heating -greenhouse effect	3.3.10.A6 Explain the phenomena that cause global atmospheric processes such as storms, currents, and wind patterns.

How has climate changed throughout the Earth's history? **3 Days**	☐ Describe how the conditions and composition of Earth's atmosphere have changed throughout Earth's history. ☐ Understand the evidence scientists use to determine past changes to Earth's climate. ☐ Investigate the properties of water and its effects on Earth materials and surface processes.	**Vocabulary:** greenhouse gas (GHG), global warming, ice age, supercontinent, ozone **Concepts:** -Milankovitch cycles -greenhouse effect	3.3.10.A7 Describe factors that contribute to global climate change.
How do human-driven factors contribute to climate change? **3 Days**	☐ Understand that current climate change is a result of the greenhouse effect. ☐ Evaluate the evidence that indicates greenhouse gases are increasing in the atmosphere due to human activity versus natural causes. ☐ Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	**Vocabulary:** anthropogenic, chlorofluorocarbons, emissions **Concepts:** -carbon cycle	7.4.12.B Analyze the global effects of human activity on the physical systems.

What are the impacts of global warming and how are predictions for future climate change made? **6 Days**	☐ Describe the impacts we already see because of a warmer climate and predict how Earth's cycles and patterns will continue to change. ☐ Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global and regional climate change and associated future impacts to the Earth's system. ☐ Describe how some impacts of climate change can trigger both positive and negative feedback loops. ☐ Compare and contrast adaptation and mitigation as strategies for addressing climate change.	**Vocabulary:** feedback, albedo **Concepts:** -sea level rise -positive and negative ecological feedback loops	3.3.10.A7 Describe factors that contribute to global climate change.

UNIT 3

Unit Title	Resources and Sustainability
Unit Description	This unit will explore the connection between the formation and availability of natural resources and how humans use them. Students will explore how humans extract and use natural resources and the impacts that extraction processes have on our resources and freshwater supply. Finally, this unit will address the broad scope of sustainability and evaluate how sustainable actions can reduce the impacts humans have on the Earth system.
Unit Assessment	Summative and formative assessments centered on key content, concepts, and understandings.

Essential Question	**Learning Goals**	**Content and Vocabulary**	**Standards**
How does the formation of non-renewable resources affect their availability? **4 Days**	☐ Understand the rock cycle, the formation of resources through the rock cycle, and the timeframe in which these respective processes occur. ☐ Know the types of non-renewable resources created through the rock cycle, such as; minerals, rocks, ore, hydrocarbons, and coal. ☐ 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. ☐ Understand how the timeframe of resource formation dictates the classification of non-renewable.	**Vocabulary:** rock, mineral, ore, igneous, metamorphic, sedimentary, kerogen, peat, non-renewable, soil **Concepts:** -rock cycle	3.3.12.A2 Analyze the availability, location, and extraction of Earth's resources. Evaluate the impact of using renewable and nonrenewable energy resources on the Earth's system.

Why is the sustainability of freshwater important? **4 Days**	☐ Understand the movement of water through the water cycle and identify the sources and uses of freshwater. ☐ Understand how water moves through the subsurface and how the structure of aquifers influences how contamination can impact groundwater. ☐ Understand the relationship between Carlisle, PA, our local watershed, and the Chesapeake Bay. ☐ 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.	**Vocabulary:** evaporation, transpiration, groundwater, aquifer, watershed, sustainability, point pollution, non-point pollution **Concepts:** -confined aquifers -contamination migration	3.3.10.A5 Explain how there is only one ocean. Explain the processes of the hydrologic cycle. 3.3.10.A7 Relate constancy and change to the hydrologic and geochemical cycles.
How is human use of natural resources affecting the Earth system? **7 Days**	☐ Describe the ways in which human activities can overuse or contaminate freshwater resources. ☐ Understand how human activity impacts the water quality of surface and ground water. ☐ Analyze the relationship between water quality parameters and the biologic health of a body of water. ☐ Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	**Vocabulary:** mining, acid mine drainage, fracking, eutrophication, nutrients, runoff, turbidity, dissolved oxygen **Concepts:** -water quality	3.3.12.A2 Analyze the availability, location, and extraction of Earth's resources. Evaluate the impact of using renewable and nonrenewable energy resources on the Earth's system.

What sustainable actions reduce the impacts of human activities on natural systems? **7 Days**	☐ Understand the principles of sustainability. ☐ Construct an argument, based on data, on why current consumption of natural resources would be considered unsustainable. ☐ Evaluate sustainable alternatives to current energy, resource, and water use. ☐ Investigate sustainable actions and evaluate their effect on resources and/or climate.	**Vocabulary:** renewable, perpetual, surplus, recharge, deficit, usage, sustainability **Concepts:** -water budgets -ecological footprint -water footprint	3.3.10.A2 Analyze the effects on the environment and the carbon cycle of using both renewable and nonrenewable sources.

UNIT 4

Unit Title	Tectonics
Unit Description	Plate tectonics is a unifying theory in geology that states that Earth is composed of pieces (plates) that move and interact; it explains the occurrence of earthquakes, volcanoes, mountain building, and the distribution of fossils.
Unit Assessment	Summative and formative assessment centered on key content, concepts, and understanding.

Essential Question	**Learning Goals**	**Content and Vocabulary**	**Standards**
What is the interior structure of the Earth and how did it form? **2 Days**	☐ Differentiate between the compositional vs. structural layers of the Earth. ☐ Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. ☐ Describe and diagram the structure of the Earth and explain how these layers formed.	**Vocabulary:** lithosphere, oceanic crust, continental crust, asthenosphere, mantle, outer core, inner core **Concepts:** -differentiation -direct and indirect evidence	3.3.10.A3 Explain how parts are related to other parts in weather systems, solar systems, and Earth systems, including how the output from one part can become an input to another part. Analyze the processes that cause the movement of material in the Earth's systems. Classify Earth's internal and external sources of energy such as radioactive decay, gravity, and solar energy.

What is the evidence that led to the Theory of Plate Tectonics? **5 Days**	☐ Discuss the evidence to support continental drift. ☐ Explain what evidence was missing from continental drift theory preventing the scientific community from supporting the theory. ☐ Construct an argument supporting the Theory of Plate Tectonics. ☐ 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.	**Vocabulary:** mid-ocean ridge, paleomagnetism, normal polarity, reversed polarity, correlation **Concepts:** -magnetic striping -seafloor spreading	3.3.10.A3 Explain how parts are related to other parts in weather systems, solar systems, and Earth systems, including how the output from one part can become an input to another part. Analyze the processes that cause the movement of material in the Earth's systems. Classify Earth's internal and external sources of energy such as radioactive decay, gravity, and solar energy.
What processes and features occur at plate boundaries? **5 Days**	☐ Understand that the lithosphere is divided into plates that are in motion with respect to one another. ☐ Describe the difference between oceanic and continental crust. ☐ Explain the three plate boundaries and the geologic features associated with each boundary. ☐ Describe the driving forces of plate movement and 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.	**Vocabulary:** oceanic crust, continental crust, subduction, rifting, trench, folding, orogeny, volcanic island arc, hot spots **Concepts:** -plate boundary types -forces of plate motion	3.3.10.A1 Relate plate tectonics to both slow and rapid changes in the Earth's surface. 3.3.10.A3 Explain how the evolution of Earth has been driven by interactions between the lithosphere, hydrosphere, atmosphere, and biosphere.

Where and how do earthquakes occur, what are the impacts, and how can we prepare for them? **4 Days**	☐ Identify the mechanism for earthquakes and explain the relationship between plate motion and fault type. ☐ Describe how the location of an earthquake can be determined. ☐ Provide examples of other hazards that can occur with and/or as an effect of earthquakes. ☐ Describe how earthquakes can affect civilization.	**Vocabulary:** earthquakes, primary waves, secondary waves, fault, epicenter, focus, intensity, Richter Scale, Mercalli Scale, tsunami **Concepts:** -elastic rebound -magnitude -triangulation -seismic waves	3.3.12.A7 Summarize the use of data in understanding seismic events, meteorology, and geologic time. 3.3.10.A1 Relate plate tectonics to both slow and rapid changes in the Earth's surface.
Where and how do volcanoes occur, what are the impacts of volcanic eruptions, and how should we prepare for them? **4 Days**	☐ Identify the reason volcanoes occur and determine where volcanoes are most likely to occur. ☐ Describe how locations and type of magma/lava affects the volcano type. ☐ Describe how volcanoes can/have affect(ed) the world by analyzing geoscience data.	**Vocabulary:** volcano, shield, composite, cinder cone, magma, lava, mafic, felsic, viscosity, pyroclastic flows, lahar, ash, landslides, outgassing **Concepts:** -types of volcanic eruptions -types of magma/lava flow	3.3.10.A1 Relate plate tectonics to both slow and rapid changes in the Earth's surface. 3.3.10.A3 Explain how the evolution of Earth has been driven by interactions between the lithosphere, hydrosphere, atmosphere, and biosphere.

ACCOMMODATIONS AND MODIFICATIONS

Adaptations or modifications to this planned course will allow exceptional students to earn credits toward graduation or develop skills necessary to make a transition from the school environment to community life and employment. The I.E.P. team has determined that modifications to this planned course will meet the student's I.E.P. needs.

Adaptations/Modifications may include but are not limited to:

INSTRUCTION CONTENT

- Modification of instructional content and/or instructional approaches
- Modification or deletion of some of the essential elements

SETTING

- Preferential seating

METHODS

- Additional clarification of content
- Occasional need for one-to-one instruction
- Minor adjustments or pacing according to the student's rate of mastery
- Written work is difficult, use verbal/oral approaches
- Modifications of assignments/testing
- Reasonable extensions of time for task/project completion
- Assignment sheet/notebook
- Modified/adjusted mastery rates
- Modified/adjusted grading criteria
- Retesting opportunities

MATERIALS

- Supplemental texts and materials
- Large print materials for visually impaired students
- Outlines and/or study sheets
- Carbonless notebook paper
- Manipulative learning materials
- Alternatives to writing (tape recorder/calculator)