Kentucky Academic Standards for Science

Unit Title	**Estimated Time Frame**
Plate Motion Engineering Internship	**12 Days**
Unit Anchor Phenomenon (Big Idea):	
Tsunamis happen in particular places.	
Design Problem Students are Trying to Solve (Essential Question):	
How can we design a better tsunami warning system for Sri Lanka?.	
Unit Three Dimensional Statement	
Students use a digital model and analyze data from iterative tests (cause and effect) and from patterns of geologic activity and plate motion (patterns) to design a tsunami warning system. Students then make arguments about how they have optimized their design solutions.	
Essential Standards (Focal Performance Expectations) (KAS for Science):	
MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **Clarification Statement:** None Provided **Assessment Boundary:** None Provided KILP: 3 - View literacy experiences as transactional, interdisciplinary and transformational. 8 - Engage in specialized, discipline specific literacy practices. 10 - Develop a literacy identity that promotes lifelong learning. **MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.** **Clarification Statement:** None Provided **Assessment Boundary:** None Provided KILP: 5 - Apply strategic practices, with scaffolding and then independently, to approach new literacy tasks. 9 - Apply high level cognitive processes to think deeply and critically about text. 10 - Develop a literacy identity that promotes lifelong learning.	

MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
Clarification Statement: None Provided
Assessment Boundary: None Provided
KILP: 6 - Collaborate with others to create new meaning.
8 - Engage in specialized, discipline specific literacy practices.
9 - Apply high level cognitive processes to think deeply and critically about text.

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
Clarification Statement: None Provided
Assessment Boundary: None Provided
KILP: 1 - Recognize that text is anything that communicates a message.
6 - Collaborate with others to create new meaning.
7 - Utilize digital resources to learn and share with others.

Supporting Standards (Connections to Other Performance Expectations):

06-ESS2-2. Construct an explanation based on evidence for how biological and geoscience processes have changed Earth's surface at varying time and spatial scales.
Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides, biological or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition caused by the movements of water, ice, and wind. Examples of biological processes could include the decomposition of living organisms resulting in soil formation, the effect of vegetation on erosion, and the impact of beaver dams on the natural flow of waterways. Emphasis is on biological processes and geoscience processes that shape local geographic features, where appropriate.
Assessment Boundary: None provided.

06-ESS2-3: Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.
Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).
Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.

08-ESS3-2: Analyze and interpret data to forecast future catastrophic events to inform the development of technologies to mitigate the effects of natural hazards.

Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado prone regions or reservoirs to mitigate droughts).

Assessment Boundary: None provided.

Connections to Kentucky Interdisciplinary Literacy Practices (KILP):

1. Recognize that text is anything that communicates a message.
3. View literacy experiences as transactional, interdisciplinary and transformational.
5. Apply strategic practices, with scaffolding and then independently, to approach new literacy tasks.
6. Collaborate with others to create new meaning.
7. Utilize digital resources to learn and share with others.
8. Engage in specialized, discipline specific literacy practices.
9. Apply high level cognitive processes to think deeply and critically about text.
10. Develop a literacy identity that promotes lifelong learning.

Connections to Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.

Science & Engineering Practices Identified in Standards (While only a subset of science and engineering practices are explicitly identified as the mechanism for how students demonstrate mastery at the end of instruction, students should still utilize all of the science and engineering practices as they develop their understanding.) NGSS Appendix F	Priority Content Disciplinary Core Ideas NGSS Appendix E	Crosscutting Concepts Identified in Standards (While only a subset of crosscutting concepts are explicitly identified as the mechanism for how students demonstrate mastery at the end of instruction, students should still utilize all of the crosscutting concepts as they develop their understanding.) NGSS Appendix G
Asking Questions and Defining Problems Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. **Engaging in Argument from Evidence** Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. **Analyzing and Interpreting** Data Analyze and interpret data to determine similarities and differences in findings. **Developing and Using Models** Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.	**ETS1.A: Defining and Delimiting Engineering Problems** ● The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. **ETS1.B: Developing Possible Solutions** ● There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. ● Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. ● A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. ● Models of all kinds are important for testing solutions. **ETS1.C: Optimizing the Design Solution** ● Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.	**Influence of Science, Engineering, and Technology on Society and the Natural World** ● All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. ● The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. ● The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

	● The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	

Prerequisite Skills for Focal Performance Expectations Science & Engineering Practices (from NGSS Appendix F and/or FCPS Enduring Science Skills Document)	**Prerequisite Disciplinary Core Ideas** (from NGSS Appendix E) (Prerequisite Content Knowledge)	**Prerequisite Crosscutting Concepts** (from NGSS Appendix G)
1. Identifies and asks scientific (testable) and non-scientific (non-testable) questions. 2. Asks questions about what would happen if a variable is changed and predict reasonable outcomes. 3. Uses prior knowledge to describe problem(s) that can be solved through the development of an object, tool, process, or system. 4. Identifies several relevant criteria for successful solution of problem(s). 5. Gives reasonable and relevant consideration to all relevant constraints of materials, time, and cost. 6. Identifies limitations of a model for a proposed tool or object (some may not be relevant.) 7. Develops models to describe and/or predict phenomena. 8. Develops a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. 9. Uses models to describe and/or predict phenomena.	**ETS1.A: Defining and Delimiting Engineering Problems** ● Use tools and materials to solve simple problems. (K-2) ● Use different representations to convey solutions (3-5) **ETS1.B: Developing Possible Solutions** ● Compare different solutions to a problem and determine which is best. (K-2) ● Define a problem using criteria for success and constraints or limits of possible solutions. (3-5) **ETS1.C: Optimizing the Design Solution** ● Research and consider multiple possible solutions to a given problem. (K-2) ● Generating and testing solutions to optimize solutions by revising them several times to obtain the best possible design.(3-5)	1. Recognize that patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. 2. Identify similarities and differences in order to sort and classify natural objects and designed products. 3. Identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions.

10. Uses a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed world. 11. Compare and contrast data collected by different groups (represented in bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. 12. Analyze, interpret and compare (across groups) data to: a. make sense of phenomena, using logical reasoning, mathematics, and/or computation to reveal patterns that indicate relationships. b. Evaluate and refine a problem statement or the design of a proposed object, tool, or process. c. Use digital tools when feasible. 13. Constructs and/or supports a scientific argument with relevant evidence, data, and/or a model. 14. Refines arguments based on an evaluation of evidence or peer critique. 15. Compares arguments based on an evaluation of the evidence presented. 16. Uses data to evaluate claims about cause and effect. 17. Distinguishes among facts, reasoned judgment based on research findings, and speculation in an explanation. 18. Respectfully provides critiques to peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.		

Preconceptions/Misconceptions:

1. A common alternate conception students have about the soft, solid portion of the mantle just below the plates is that it is composed of a sea of hot, liquid magma upon which the plates "float." In fact this upper portion of the mantle, called the asthenosphere, is a layer of solid rock with more ductile properties than the tectonic plates above it. (This is due to the pressure and temperature conditions under Earth's surface.) This understanding of mantle is informed by multiple lines of evidence that have revealed how this layer deforms in response to stress. Under different short-term conditions, the asthenosphere can deform elastically or plastically to stress. When stress is applied over long periods of time, the asthenosphere will flow in response. The specific viscoelastic properties of the mantle are beyond the scope of this unit.

2. The gravitational pull of the sun and Moon on Earth also causes waves. These waves are sometimes referred to as tidal waves. Tsunamis have been incorrectly called tidal waves, possibly due to the fact that they sometimes arrive on land like a fast-rising tide and cause flooding. The cause of tsunamis is not related to tides, which may be an alternate conception. Wind-driven ocean waves are caused by friction between air currents at the surface of the water. Thus, it's only the water at the surface that moves during the production of this type of wave. These common waves that we see at the beach tend to arrive on the shore every few seconds to a few minutes. A wind-driven wave has smaller crests and shorter wavelengths and, thus, transfers less energy and is less damaging compared to a tsunami wave.

Pedagogical Considerations:

1. We use the term plate to refer to the lithosphere, the outermost layer of Earth (the uppermost portion of this layer is referred to as crust). We use the term mantle to refer to the asthenosphere, the ductile portion of the upper mantle just below the lithosphere. These terms were selected in order to prioritize students' understanding of plate behavior without having to memorize and use technical terms. For the same reason, we chose to refer to plates with the simple term rather than the longer and more technical term tectonic plates.

2. It is possible for tsunamis to occur in large bodies of water, including lakes, but due to the focus of the Indian Ocean region in this unit, we only discuss tsunamis in oceans.

Essential Vocabulary:

cross section	pattern	mantle	mid-ocean ridge	analyze
outer layer	plate boundary	convergent	trench	rate
plate	earthquake	divergent	volcanic activity	

Assessment Profile:
FCPS 6th Grade Common Unit Assessment Folder Each Engineering Internship is designed as a student-centered learning and assessment experience in which students design, test, analyze, iterate, and write design arguments for their solutions to an authentic problem. Through this experience, students engage in the eight science and engineering practices and apply disciplinary core ideas and crosscutting concepts from the associated unit in order to consider trade-offs and optimize their designs to meet a set of design criteria and constraints. As such, students' work throughout the 10-day internship can be used as a performance assessment of their understanding of core concepts and crosscutting concepts and of their facility with the science and engineering practices. In addition, the Proposal Rubric that is shared with students can be used to support assessment of the science and engineering practices of Designing Solutions; Engaging in Argument from Evidence; and Obtaining, Evaluating, and Communicating Information.
Other High Quality Resources
Next Generation Science Standards - Quality Examples of Science Lessons and Units Open SciEd Classroom Resources
FCPS Resources
FCPS Achievement & Trauma-Informed Strategies in the Classroom

Individual lesson information to be completed at the school level based on pre-unit assessment data and formative assessment data.

Chapter 1 Problem Students are Trying to Solve: (Supporting Question)				
Design a better tsunami warning system for Sri Lanka.				
Design Problem Three Dimensional Statement:				
Students use a digital model and analyze data from iterative tests (cause and effect) and from patterns of geologic activity and plate motion (patterns) to design a tsunami warning system. Students then make arguments about how they have optimized their design solutions.				
		Anchor Resource Connections		
Lesson Learning Intention (describes clearly what the students will know and/or be able to do as a result of learning and teaching.)	**Lesson Success Criteria** (based on lesson sequence and connections to Learning Intention)	**Learning Progression** (from "Evidence sources and reflection opportunities" AND "Application of key concepts to problem" on the Coherence Flowchart)	**Key Concepts** (from Key Concepts section on the Coherence Flowchart)	**Amplify Progress Build Level** (these are found in Planning for the Unit on the Unit Landing Page in Progress Build)
I am learning to obtain and evaluate information from text so that I can define an engineering problem.	I know I am successful when I can: • explain the role of a geohazards engineer. • explain the internship phases. • define criteria. • use the Tsunami Alert model. • read and annotate text to acquire information about tsunamis.	• Introducing the Engineering Internship		

I am learning to use a model so that I can investigate natural phenomena.	I know I am successful when I can: ● obtain information from the media and an investigation to visualize wind-driven waves. ● obtain information from a text to explain the relationships between plate motion and tsunamis.	● Modeling a Tsunami Wave		
I am learning to gather, analyze, and apply evidence from a model and from text so that I can determine whether earthquakes at plate boundaries are capable of causing tsunamis..	I know I am successful when I can: ● explain Scientific Communication. ● identify plate boundaries. ● discuss plate boundaries and plate boundary locations. ● use a model to explore plate boundaries. ● discuss the relationship between types of plate boundaries and locations of tsunamis.	● Researching Plate Motion		
I am learning to obtain and evaluate information and perform tests so that I can begin designing the best locations for sensors.	I know I am successful when I can: ● use active reading strategies to obtain information from text. ● explain how tsunami warning systems work ● analyze different types of sensors. ● use a model to evaluate sensors.	● Learning About Tsunami Warning Systems		

I am learning to iteratively test design solutions, observing how changes to the design affect the outcome so that I can communicate the strongest design solutions for feedback.	I know I am successful when I can: • explain the Design Cycle. • define iterative testing. • use a model to carry out multiple tests. • analyze test data and evaluate designs against a criteria. • communicate results.	• Designing Tsunami Warning Systems		
I am learning to	I know I am successful when I can: •	• Choosing an Optimal Design		
I am learning to	I know I am successful when I can: •	• Composing Proposal Outlines		
I am learning to	I know I am successful when I can: •	• Writing Design Decisions		
I am learning to	I know I am successful when I can: •	• Completing the Proposal		
I am learning to	I know I am successful when I can: •	• Applying Engineering Skills		

Other High Quality Resources
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