**Stanford NGSS Integrated Curriculum: An Exploration of a Multidimensional World**

**Unit 2: Extreme Living**

**Essential Question:** How do people use technology to survive in regions with different climates?

**Total Number of Instructional Days:** 38.5

**Group Culminating Project:**

Present a Thermal Product for Enhanced Comfort in Extreme Weather Regions

**Individual Culminating Project**

Write a Consumer Report That Reviews the Thermal Product and the Science Behind It

**Lift-Off Task:**

Extreme Conditions

**Task 2:**

Climate, Part 2: Oceans and Atmosphere

**Task 3:**

A Water Molecule’s Journey

**Task 4:**

Thermal Energy Transfer

Connect to the Culminating Project using the Project Organizer

**Task 5:**

Extreme Living Solutions

**Task 1:**

Climate, Part 1: Heating the Planet

**Unit 2 Pop-Out**

**Storyline for Unit 2**

In some regions of the world, nature can be pretty extreme! Despite these extreme climate conditions, humans are somehow able to flourish in seemingly inhospitable regions on Earth. In this unit, students consider factors that create regions with extreme climates, and how people can use technology to survive in those regions.

In the Lift-Off Task, students analyze photos of humans living in extreme climates and begin to generate questions about this phenomenon. These questions guide students throughout the unit as they continue to make sense of extreme climates, and use scientific ideas to design products that make living in these regions possible.

In the next two tasks, students explore the causes for extreme climates like the ones introduced in the Lift-Off. To begin this exploration, students consider first the Sun because it is the key energy source behind all mechanisms that determine regional climates. In Task 1, students use physical and computer simulation models to visualize the Sun-Earth system. Through these models, they will notice that the Sun does not heat all parts of the Earth equally because of the tilt of the Earth as it orbits around the Sun. This is a major cause for the extreme climate in the regions students chose for their culminating project.

In Task 2, through the use of demonstrations and video simulations, students delve into how the unequal heating they explored in Task 1 causes patterns of atmospheric and oceanic circulation that act to redistribute the Sun’s energy around the Earth, further affecting regional climate patterns. By the end of this task, students will be able to add to their explanation of their region’s extreme climate from Task 1.

In Task 3, students further examine another important process that regulates climates—the water cycle. Here, students do a kinesthetic activity to simulate the journey of a water molecule, allowing them to explore the places where water is found and how it travels. In the end, students will apply their knowledge to consider how the water cycle contributes to the climate conditions in their chosen region for their culminating project.

Until now, students have thought about the context for their design problem—the causes of different climates around the world. Remaining in their task for the project is for students to design a product that makes it possible to live in a region with extreme climate. In order to design such a product, students need to understand the concept of temperature. In Task 4, students plan and conduct investigations to figure out what happens at the molecular level and what factors affect temperature change. This lays a foundation for students to envision the type of product they will design for their culminating project and the factors they should consider.

In Task 5, students use new ideas developed from their own investigations to design their products! Throughout this task, students engage with a series of guided steps to help them brainstorm, design, build, test, and revise a prototype that makes it possible to live in a region with extreme temperatures. By the end of the task, students will have a clear idea of the product they want to present as their culminating project, including an understanding of the science behind how it works, and the engineering process required to build a final product.

Once students have completed all tasks and their Project Organizer, they can begin work on their culminating project. As students have already chosen a region with an extremely hot or cold climate, their job is to design a product that makes it more comfortable for people to live in this region, and then to present their product in a format of their choice. After presenting, each student then writes a consumer report to review the science behind why the product is needed and how the product works, again in a format of their choice.

**Three-Dimensional Breakdown of the Performance Expectations**

This unit was developed to align with, teach, and assess students’ understanding and skills related to these Performance Expectations. Below, we have mapped out the disciplinary core ideas, crosscutting concepts, and science and engineering practices addressed in this unit. Aspects of the dimensions that are not explicitly addressed in this unit are crossed out.

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| **Performance Expectations** | **Scientific and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **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.** | **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. | **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. | **No CCC listed** |
| **MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.** [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.] | **Developing and Using Models**   * Develop and use a model to describe phenomena. | **ESS2.C: The Roles of Water in Earth’s Surface Processes**   * Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.   **ESS2.D: Weather and Climate**   * Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, ~~landforms, and living things.~~ These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. * The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. | **Systems and System Models**   * Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. |
| **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.** [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.] | **Developing and Using Models**   * Develop a model to describe unobservable mechanisms. | **ESS2.C: The Roles of Water in Earth’s Surface Processes**   * Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. * Global movements of water and its changes in form are propelled by sunlight and gravity. | **Energy and Matter**   * Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. |
| **MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.** [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] | **Planning and Carrying Out Investigations**   * Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. | **PS3.A: Definitions of Energy**   * Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.   **PS3.B: Conservation of Energy and Energy Transfer**   * The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. | **Scale, Proportion, and Quantity**   * Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. |
| **MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.\*** [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] | **Designing Solutions**   * Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process, or system. | **PS3.A: Definitions of Energy**   * Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.   **PS3.B: Conservation of Energy and Energy Transfer**   * Energy is spontaneously transferred out of hotter regions or objects and into colder ones. | **Energy and Matter**   * The transfer of energy can be tracked as energy flows through a designed or natural system. |
| **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.** | **Analyzing and Interpreting Data**   * Analyze and interpret data to determine similarities and differences in findings. | **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.   **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. | **No CCC listed** |

**Connections to Common Core Math and ELA Standards:**

Over the course of this unit, students will gain knowledge and skills in science, as well as in math and English-Language Arts. Below we list the Common Core ELA and Math standards for middle school and 6th grade that are relevant to the curriculum tasks in this unit. Within the curriculum, there are opportunities to incorporate components of the following ELA and Math Standards:

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| **Middle School and 6th Grade Common Core ELA Standards** | | **Unit Task** |
| **Key Ideas and Details** | CCSS.ELA-Literacy.RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts. | Task 2  Task 4 |
| CCSS.ELA-Literacy.RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. | Task 1  Task 3  Task 4  Task 5 |
| **Integration of Knowledge and Ideas** | CCSS.ELA-Literacy.RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. | Task 2  Task 4 |
| **Research to Build and Present Knowledge** | CCSS.ELA-Literacy.WHST.6-8.7: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. | Lift-Off Task  Task 1  Task 5  Culminating Project |
| CCSS.ELA-Literacy.WHST.6-8.8: Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. | Lift-Off Task  Task 1  Task 5  Culminating Project |
| **Presentation of Knowledge and Ideas** | CCSS.ELA-Literacy.SL.8.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. | Task 1  Task 2  Task 5  Culminating Project |

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| **Middle School and 6th Grade Common Core Math Standards** | | **Unit Task** |
| **Mathematical Practice** | CCSS.MATH.MP.2: Reason abstractly and quantitatively. | Task 1  Task 2  Task 4  Task 5  Culminating Project |
| **Summarize and Describe Distributions** | CCSS.MATH. CONTENT.6.SP.B.5: Summarize numerical data sets in relation to their context. | Task 2  Task 4  Task 5  Culminating Project |

**Connections to English Language Development (ELD) Standards:**

We acknowledge that language development is a key component of disciplinary understanding and helps to support more rigorous and equitable outcomes for diverse students. This curriculum thus takes into account both the receptive and productive language demands of the culminating projects and strives to increase accessibility by including scaffolds for language development and pedagogical strategies throughout learning tasks. We aim to support language acquisition through the development of concept maps; utilizing sentence frames; implementing the Critique, Correct, Clarify technique; employing the Stronger Clearer strategy; and fostering large and small group discussions.

The California ELD Standards are comprised of two sections: the standards and a rubric. Outlined below are the standards from Section One that are met within this curriculum. For additional information, please refer to: https://www.pausd.org/sites/default/files/pdf-faqs/attachments/SS\_ELD\_6.pdf.

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| **6th Grade ELD Standards** | | |
| **Part I: Interacting in Meaningful Ways** | A: Collaborative | 1.Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics |
| 2. Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia) |
| 3. Offering and justifying options, negotiating with and persuading others in communicative exchanges |
| 4. Adapting language choices to various contexts (based on task, purpose, audience, and text type) |
| B: Interpretive | 5. Listening actively to spoken English in a range of social and academic contexts |
| 6. Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language |
| 7. Evaluating how well writers and speakers use language to support ideas and arguments with details or evidence depending on modality, text type, purpose, audience, topic, and content area |
| 8. Analyzing how writers and speakers use vocabulary and other language resources for specific purposes (to explain, persuade, entertain, etc.) depending on modality, text type, purpose, audience, topic, and content area |
| C: Productive | 9. Expressing information and ideas in formal oral presentations on academic topics |
| 10. Writing literary and informational texts to present, describe, and explain ideas and information, using appropriate technology |
| 11. Justifying own arguments and evaluating others’ arguments in writing |
| 12. Selecting and applying varied and precise vocabulary and other language resources to effectively convey ideas |
| **Part II: Learning About How English Works** | A: Structuring Cohesive Texts | 1. Understanding text structure |
| 2. Understanding cohesion |
| B: Expanding and Enriching Ideas | 3. Using verbs and verb phrases |
| 4. Using nouns and noun phrases |
| 5. Modifying to add details |
| C: Connecting and Condensing Ideas | 6. Connecting ideas |
| 7. Condensing ideas |

**Connections to Environmental Awareness:**

Over the course of this curriculum, students will explore content related to various environmental principles and concepts that examine the interactions and interdependence of human societies and natural systems. In accordance with the *Education and the Environment Initiative (EEI),* tasks throughout this curriculum explore many of *California’s Approved Environmental Principles and Concepts.*

While this unit does focus on how humans survive within natural systems, it does not explicitly examine the how humans impact natural systems. In later units, we will outline the EEI principles relevant to the unit in this section of the unit overview.