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

**Unit 1: Colossal Collisions**

**Essential Question:** What are the effects of an asteroid collision and how can we prevent a future one?

**Total Number of Instructional Days:** 29.5 – 30.5

**Unit 1 Pop-Out**

What is a Scientist?

(*Implement after project*)

**Group Culminating Project:**

Create a video news segment describing a plan to prevent an asteroid collision.

**Individual Culminating Project**

Write a news article detailing the science behind plans to prevent an asteroid collision.

**Lift-Off Task:**

Asteroid Collisions

**Task 1:**

An Ancient Collision

**Task 2:**

Contact Forces

**Task 3:**

Gravity – A Non-Contact Force

Connect to the Culminating Project using the Project Organizer

**Storyline for Unit 1**

It is largely believed that about 65 million years ago, a large asteroid collided with Earth, causing a huge explosion and a cascade of worldwide effects—the most well-known effect being the extinction of dinosaurs from our planet. In the Lift-Off Task, students are introduced to the phenomenon of this historical asteroid collision and asked to generate a list of questions they would ask in order to learn more. As they explore these questions throughout the unit, students will begin to conceptualize the potential impacts of an asteroid collision and start to envision what kinds of solutions they could use to prevent another large-scale collision with Earth, which is their culminating project for this unit.

In order to gather more information for their culminating project, students first need to investigate evidence that a collision of this magnitude has indeed happened before and find out what the effects were. In Task 1, students analyze different pieces of evidence that document the existence, diversity, extinction, and change of life forms on Earth due to a major asteroid collision that occurred 65 million years ago. By gathering this evidence, students will be able to explain to the public why it is so important that they do everything they can to prevent something like this happening again.

However, to prevent another asteroid collision, they need to learn more about the scientific concepts of forces and motion that they will use to do so. In Task 2, students investigate what factors affect the motion of objects and use this knowledge to help prevent a collision. By planning and carrying out their own investigations with everyday materials, students can leverage their experiential knowledge of objects in motion and begin to ascribe scientific concepts to these experiences. By the end of this task, students will be able to understand an asteroid’s collision with Earth within the context of mass, forces, and motion, and use this new knowledge to brainstorm ideas on deflecting the asteroid.

In Task 3, students explore another, less tangible force that also affects how objects move and collide—gravity. In this task, students collect information from multiple resources to find that gravity does not just attract objects towards Earth, but also towards other bodies, and that this attraction has everything to do with an object’s mass. By the end of this task, students will be able to dispel some common misconceptions about gravity and use their new understanding to brainstorm more ways to prevent the asteroid collision with Earth.

Once students are complete with all tasks, they begin to develop plans to thwart the impending asteroid collision with Earth. Once each group makes a decision on what their solution to save Earth is, each group will create a video news segment that describes how they plan to prevent this impending collision. As individuals, they will then write a detailed news article for people who want to know more about asteroid collisions with Earth and the science behind making this decision.

**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-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past**. [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.] | **Analyzing and Interpreting Data**   * Analyze and interpret data to determine similarities and differences in findings. | **LS4.A: Evidence of Common Ancestry and Diversity**   * The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. | **Patterns**   * Graphs, charts, and images can be used to identify patterns in data. |
| **MS-PS2-2**. **Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object**. [Clarification Statement: Emphasis is on balanced (Newton’s First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton’s Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.] | **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. | **PS2.A: Forces and Motion**   * The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. * ~~All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.~~ | **Stability and Change**   * Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. |
| **MS-PS2-1**. **Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.\*** [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.] | **Designing Solutions**   * Apply scientific ideas or principles to design an object, tool, process or system. | **PS2.A: Forces and Motion**   * For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton’s third law). | **Systems and System Models**   * Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. |
| **MS-PS3-1**. **Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object***.* [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.] | **Analyzing and Interpreting Data**   * Construct and interpret graphical displays of data to identify linear and nonlinear relationships. | **PS3.A: Definitions of Energy**   * Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. | **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-PS2-4**.**Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.** [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton’s Law of Gravitation or Kepler’s Laws. | **Engaging in Argument from Evidence**   * Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. | **PS2.B: Types of Interactions**   * Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. | **Systems and System Models**   * Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. |
| **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-ETS1-2***.* **Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.** | [**Engaging in Argument from Evidence**](http://www.nap.edu/openbook.php?record_id=13165&page=71)   * [Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.](http://www.nap.edu/openbook.php?record_id=13165&page=71) | [**ETS1.B: Developing Possible Solutions**](http://www.nap.edu/openbook.php?record_id=13165&page=206)   * There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. | **No CCC listed** |
| **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** |
| **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.** | [**Developing and Using Models**](http://www.nap.edu/openbook.php?record_id=13165&page=56)   * Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. | **ETS1.B: Developing Possible Solutions**   * [A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.](http://www.nap.edu/openbook.php?record_id=13165&page=206) * Models of all kinds are important for testing solutions.   **ETS1.C: Optimizing the Design Solution**   * 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. | **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 8th 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 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, attending to the precise details of explanations or descriptions. | Task 1  Task 3  Culminating Project |
| CCSS.ELA-Literacy. RST. 6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. | Task 2  Task 3  Culminating Project |
| **Integration of Knowledge and Ideas** | CCSS.ELA-Literacy.RST.6-8.9: 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). | Task 1  Culminating Project |
| 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 1  Task 3 |
| **Text Types and Purposes** | CCSS.ELA-Literacy.WHST.6-8.1: Write arguments focused on discipline content. | Task 3 |
| **Research to Build and Present Knowledge** | 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. | Task 1  Task 3  Culminating Project |
| CCSS.ELA-Literacy.WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research. | Task 1  Culminating Project |

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| **Middle School and 8th Grade Common Core Math Standards** | | **Unit Task** |
| **Mathematical Practice** | CCSS.MATH.MP.2: Reason abstractly and quantitatively. | Task 2  Task 3  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\_8.pdf.

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| **Eighth 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. Analyze 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 focuses on how a natural disaster can affect natural systems, it does not explicitly examine the interactions of *humans* and natural systems. In later units, we will outline the EEI principles relevant to the unit in this section of the unit overview.