HILLSBOROUGH TOWNSHIP SCHOOL DISTRICT

SCIENCE CURRICULUM

GEOPHYSICS

AUGUST 2021

Hillsborough Township Public Schools
Geophysics Curriculum

Unit Title	**Time Frame/Pacing**
Plate Tectonics	5 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Anchoring Phenomena:

- Some Hawaiian Islands have active volcanoes while others have extinct volcanoes.

Anchoring Question:

- Why do volcanoes tend to propagate along plate boundaries?

Investigative Phenomena:

- Formation of Atlantis, Myth of Pele
- Ability to dive between continents (Mid-Atlantic Ridge)
- Earthquake in Virginia
- Flipping of magnetic poles
- GPS in Australia is wrong

Essential Questions:

- How does crustal movement and the theory of plate tectonics determine the age of continental rocks?

Enduring Understandings

- Objects accelerate when an unbalanced force is applied
- Newton's Laws explain movement of Earth formations.
- Rocks forming the continents are generally much older than the rocks of the ocean floor.
- The theory of Plate Tectonics explains the past and current movements as well as the history of the rocks at Earth's surface.
- Radiometric dating can be used to determine the ages of rocks and other materials.
- Convection Currents make things move on Earth.
- Radioactive decay is responsible for temperature of the Earth.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Asking Questions and Defining Problems • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. **Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process,	**ESS1.C** • The History of Planet Earth Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. **ESS2.B** • Plate Tectonics and Large-Scale System Interactions Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. **PS1.C** • Nuclear Processes Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. **Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Systems can be designed to cause a desired effect. **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

or system. **Constructing Explanations and Designing Solutions** • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.		

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with Mathematics.
- HSN-Q.A.2 Reason quantitatively and use units to solve problems - Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3 Reason quantitatively and use units to solve problems - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

ELA

- RST.11-12.1 Science and Technical Subjects- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- SL.11-12.5 Speaking and Listening- Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Computer Science and Design Thinking

- 8.2.12.D.1 Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
- 8.2.12.C.7 Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials.
- 8.2.12.B.4 Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.

Career Readiness, Life Literacies, and Key Skills

- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
- 9.3.ST-ET.2 Display and communicate STEM information.
- 9.3.ST-ET.4 Apply the elements of the design process.

Social-Emotional Learning Competencies

- **Responsible Decision-Making:** The abilities to make caring and constructive choices about personal behavior and social interactions across diverse situations.
- **Relationship Skills:** The abilities to establish and maintain healthy and supportive relationships and to effectively navigate settings with diverse individuals and groups.

Learning Targets	Investigations/Resources	Formative Assessment
Explain that crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and formation of new rocks from magma rising where plates are moving apart.	• Paleomagnetism- Seafloor Spreading ○ Magnetism and Poles investigation - Discussion on compasses? • Paleomagnetism Video • Magnetic Stripes Activity • Seafloor Spreading and Paleomagnetism- includes math • Topographical map of Earth	Plate Tectonics EdPuzzle
Evaluate and critique evidence including: • Measurement of the ratio of parent to daughter atoms produced during radioactive decay as a means for determining the ages of rocks; • Ages and locations of continental rocks; • Ages and locations of rocks found on opposite sides of mid-ocean ridges; and • The type and location of plate boundaries relative to the type, age, and location of crustal rocks.	• Possible radioactive decay lesson • Video of Thorium in a Cloud Chamber • Modeling Radioactive Decay Lab • PhET Alpha Decay Lab	CER: How patterns of crustal formation and crustal destruction influence continental and oceanic crust?

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Reason how the following patterns observed from the evidence support the explanation about the ages of crustal rocks: • The pattern of the continental crust being older than the oceanic crust; • The pattern that the oldest continental rocks are located at the center of continents, with the ages decreasing from their centers to their margin; and • The pattern that the ages of oceanic crust are greatest nearest the continents and decrease in age with proximity to the mid-ocean ridges.	• Newton's 3rd Law- Investigation of Newtonian Forces as a demo	

Synthesize the relevant evidence to describe the relationship between the motion of continental plates and the patterns in the ages of crustal rocks, including that:
• At boundaries where plates are moving apart, such as mid-ocean ridges, material from the interior of the Earth must be emerging and forming new rocks with the youngest ages.
• The regions furthest from the plate boundaries (continental centers) will have the oldest rocks because new crust is added to the edge of continents at places where plates are coming together, such as subduction zones.
• The oldest crustal rocks are found on the continents because oceanic crust is constantly being destroyed at places where plates are coming together, such as subduction zones.
	• Convection Currents Lab
	• Subduction zones
	  ○ Introductory phenomenon - Why are there more major Earthquakes around the Pacific ocean (ring of fire), rather than the Atlantic ocean?
	  ○ Readings
	  ■ Primary Source
	  ■ Secondary Source
	  ○ Physics application on density: crusts that are similarly dense (such as a continent-continent collision) will crumple like two cars in a collision, forming a mountain range (such as the Himalayas). When two crusts of different densities collide, the denser oceanic crust will typically slide under the lighter continental crust
	  ○ Slab Pull theory
	• Modeling the Asthenosphere Lab
		Tectonic Explorer
		
		Students research and create a diorama to model a subduction zone and explain its significance on Earth.

	• Earthquakes Living Lab- The Theory of Plate Tectonics • ShakeOut; Finding Plates	
Seafloor Spreading and Continental Drift Theories combine to help create the Plate Tectonics Theory	• Far Flung Fossil Activity- Continental Drift • Seafloor Spreading CK12 activities • Plate Tectonics Gizmo • Building Pangaea Gizmo	Construct a dynamic model showing multiple tectonic forces responsible for forming continental crust.

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• South American Cratons • Can you predict where a plate boundary is formed? • Create a timeline of the events and processes responsible for the present day North American continent.	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites. .

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Unit Title	**Time Frame/Pacing**
Structure of Earth	7 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Anchoring Phenomena:

- Old Faithful

Anchoring Question:

- How does convection affect our Earth's interior?
- How was Yellowstone formed from natural processes?

Phenomena:

- Changing Rivers
- Sink hole
- Mud Volcanoes
- Magnets & Copper

Essential Questions:

- What is the importance of convection?
- What determines the internal structure of the Earth?
- How do the Earth's surface features form?

Enduring Understandings

- The Earth consists of a hot but solid inner core, a liquid outer core, a solid mantle and crust. This is based on evidence from deep probes, seismic waves, reconstructions of past changes in Earth's surface and its magnetic field.
- Movement of the mantle and tectonic plates occur mainly through thermal convection.
- The interior of the Earth remains very hot due to the continual decay of radioactive isotopes generating new energy within the Earth's. This heat energy drives convection, which results in the features and processes associated with plate tectonics.
- Earth's dynamic systems interact and can increase or decrease the effects of changes that have already taken place.
- Plate tectonics is responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

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

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. **Constructing Explanations and Designing Solutions** • Design, evaluate, and/or refine a solution to	**ESS2.A** • Earth Materials and Systems Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. **ESS2.B** • Plate Tectonics and Large-Scale System Interactions Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust.	**Cause and Effect** • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. **Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1) • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.		

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with Mathematics.
- HSN-Q.A.2 Reason quantitatively and use units to solve problems- Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3 Reason quantitatively and use units to solve problems- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSN-Q.A.1 Reason quantitatively and use units to solve problems- Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

ELA

- RST.11-12.1 Science and Technical Subjects- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- SL.11-12.5 Speaking and Listening- Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Computer Science and Design Thinking

- 8.2.12.B.4 Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.
- 8.2.12.B.5 Research the historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product, and present the competing viewpoints to peers for review.
- 8.2.12.C.2 Analyze a product and how it has changed or might change over time to meet human needs and wants.
- 8.2.12.C.7 Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials.
- 8.2.12.D.1 Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.

Career Readiness, Life Literacies, and Key Skills

- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.

- 9.3.ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.
- 9.3.ST-ET.1 Use STEM concepts and processes to solve problems involving design and/or production.
- 9.3.ST-ET.2 Display and communicate STEM information.
- 9.3.ST-ET.4 Apply the elements of the design process.
- 9.3.ST-ET.5 Apply the knowledge learned in STEM to solve problems.
- 9.3.ST-SM.2 Apply science and mathematics concepts to the development of plans, processes and projects that address real world problems.
- 9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.

Social-Emotional Learning Competencies

- **Responsible Decision-Making:** The abilities to make caring and constructive choices about personal behavior and social interactions across diverse situations.
- **Relationship Skills:** The abilities to establish and maintain healthy and supportive relationships and to effectively navigate settings with diverse individuals and groups.
- **Self Management:** The abilities to manage one's emotions, thoughts, and behaviors effectively in different situations and to achieve goals and aspirations.

Learning Targets	Investigations/Resources	Formative Assessment
Develop a model to identify and describe the components based on both seismic and magnetic evidence (e.g., the pattern of the geothermal gradient or heat flow measurements) from Earth's interior, including: • Earth's interior in cross-section and radial layers (crust, mantle, liquid outer core, solid inner core) determined by density; • The plate activity in the outer part of the geosphere; • Radioactive decay and residual thermal energy from the formation of the Earth as a source of energy; • The loss of heat at the surface of the earth as an output of energy; and	• CK12 Earth's Layers • Incorporated Research Institutions for Seismology (IRIS) Seismic Wave Simulator • Determining and Measuring Earth's Layered Interior • Rock cycle	• Convection in the Mantle Lab • Modeling the material of the Asthenosphere. • Distinguish between constructive and destructive forces. • Explain how the Rocky Mountains were formed.

• The process of convection that causes hot matter to rise (move away from the center) and cool matter to fall (move toward the center).		
Describe the relationships between components in the model, including: • Energy released by radioactive decay in the Earth's crust and mantle and residual thermal energy from the formation of the Earth provide energy that drives the flow of matter in the mantle. • Thermal energy is released at the surface of the Earth as new crust is formed and cooled. • The flow of matter by convection in the solid mantle and the sinking of cold, dense crust back into the mantle exert forces on crustal plates that then move, producing tectonic activity. • The flow of matter by convection in the liquid outer core generates the Earth's magnetic field. • Matter is cycled between the crust and the mantle at plate boundaries. Where plates are pushed together, cold crustal material sinks back into the mantle, and where plates are pulled apart, mantle material can be integrated into the crust, forming new rock.	• Conduction and Convection Gizmo • Review of radioactive decay & subduction zones	
Make connections by using the model to describe the cycling of matter by thermal convection in Earth's interior, including: • The flow of matter in the mantle that causes crustal plates to move;	• Modeling convection currents • Modeling asthenosphere material	• Model to show flow of matter and energy in the system

• The flow of matter in the liquid outer core that generates the Earth's magnetic field, including evidence of polar reversals (e.g., seafloor exploration of changes in the direction of Earth's magnetic field); • The radial layers determined by density in the interior of Earth; and • The addition of a significant amount of thermal energy released by radioactive decay in Earth's crust and mantle.		
Use evidence to develop a model to identify and describe: • Descriptions and locations of specific continental features and specific ocean-floor features; • A scale showing the relative size and extent of a particular continental and/or ocean floor feature; • Internal processes (such as volcanism and tectonic uplift) and surface processes(such as weathering and erosion); and • A scale showing the relative times over which various processes act to produce features in the continents and ocean-floor.	Sonar Lesson Plan	
Describe the relationships between components, including: • Internal processes, mainly volcanism, mountain building or tectonic uplift, that build up Earth's surface over time. • Surface processes, mainly weathering and erosion, that wearing down Earth's surface over time. • Interactions and feedbacks between processes (e.g., mountain-building	Relative Age Dating- Packet	

• changes weather patterns that then change the rate of erosion of mountains). • The differing rate at which the features change depends on its time scale.		
Use the model to make connections between 1) the formation of continental and ocean floor features and 2) Earth's internal and surface processes operating on different temporal or spatial scales and 3)the destructive forces including the agents of erosion		
Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)		
Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this: • Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.		
Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**	
• Develop a scale model of Earth's interior illustrating the cycling of matter by thermal convection.(flow arrows) • Write a story of Yellowstone using pictures and diagrams to show all internal and surface processes responsible for its formation.	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.	

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Unit Title	**Time Frame/Pacing**
Formation of Earth	3-4 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:
- Planetary bodies can help us determine how the Earth formed.

Anchoring Activity/Question:
- Meteorites and asteroids can be clues to our planet's early history.

Essential Questions:
- What types of meteorites are there?
- How have planetary bodies affected the formation of our Earth?

Enduring Understandings

- Objects in the solar system such as lunar rocks, asteroids, comets, and meteorites have not significantly changed over billions of years. They can help determine Earth's formation and early history since Plate tectonics and erosion have destroyed or altered most of the very early rock record.
- Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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 earth history.

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts**
Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a	**ESS1.C** • The History of Planet Earth Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record	**Cause and Effect** • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by

system. **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. **Constructing Explanations and Designing Solutions** • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. **PS1. C** • Nuclear Processes Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.	examining what is known about smaller scale mechanisms within the system. **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. **Stability and Change** • Systems can be designed for greater or lesser stability. **Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math
- MP.2 Reason abstractly and quantitatively.
- HSN-Q.A.1 Reason quantitatively and use units to solve problems- Use units as a way to understand problems and to guide the solution of multi-step

problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

- HSN-Q.A.2 Reason quantitatively and use units to solve problems - Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3 Reason quantitatively and use units to solve problems - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSF-IF.B.5 Interpreting Functions - Interpret functions that arise in applications in terms of the context- Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person - hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.
- HSS-ID.B.6 Statistics & Probability - Interpreting Categorical & Quantitative Data- Summarize, represent, and interpret data on two categorical and quantitative variables- Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

ELA

- RST.11-12.1 Science and Technical Subjects - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.8 Science and Technical Subjects - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- WHST.9-12.1 Writing - Write arguments focused on discipline-specific content.

Computer Science and Design Thinking

- 8.2.12.B.4 Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.

Career Readiness, Life Literacies, and Key Skills

- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
- 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.
- 9.3.ST-ET.3 Apply processes and concepts for the use of technological tools in STEM.
- 9.3.ST-ET.5 Apply the knowledge learned in STEM to solve problems.
- 9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.

Social-Emotional Learning Competencies

- **Self Management:** The abilities to manage one's emotions, thoughts, and behaviors effectively in different situations and to achieve goals and aspirations.
- **Responsible Decision-Making:** The abilities to make caring and constructive choices about personal behavior and social interactions across diverse situations.

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Learning Targets	Investigations/Resources	Formative Assessment
Construct an account of Earth's formation and early history that includes that: • Earth formed along with the rest of the solar system 4.6 billion years ago. • The early Earth was bombarded by impacts just as other objects in the solar system were bombarded. • Erosion and plate tectonics on Earth have destroyed much of the evidence of this bombardment, explaining the relative scarcity of impact craters on Earth.	• Scaled model of Geologic Timeline • Formation of Earth Instructional Resources • Earth Impact- Change to account for qualitative force, distance, and kinetic energy • Look for resources on impact craters that have been discovered	• Meteorites, Clues to Solar System History activity. • Compare and contrast meteorites, asteroids, comets and associated impact craters. • Students will create a model showing how the Earth's formation proceeded.
Explain evidence of: • The age and composition of Earth's oldest rocks, lunar rocks, and meteorites as determined by radiometric dating; • The composition of solar system objects; • Observations of the size and distribution of impact craters on the surface of Earth and on the surfaces of solar system objects; and • The activity of plate tectonic processes, such as volcanism, and surface processes, such as erosion, operating on Earth.	Stratigraphic column lab	
Use reasoning to connect the evidence to construct the explanation of Earth's formation and early history, including that: • Radiometric ages of lunar rocks, meteorites and the oldest Earth rocks point to an origin of the solar system 4.6 billion years ago, with the creation of a solid Earth crust about 4.4 billion years ago. • Other planetary surfaces and their patterns of impact cratering can be used to infer that	Asteroids- Teach Engineering	CER Formation of Earth (CA)

Earth had many impact craters early in its history. • The relative lack of impact craters and the age of most rocks on Earth compared to other bodies in the solar system can be attributed to processes such as volcanism, plate tectonics, and erosion that have reshaped Earth's surface, and that this is why most of Earth's rocks are much younger than Earth itself.		

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Formation of Earth CA	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

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Unit Title	**Time Frame/Pacing**
The Sun and the Life Cycle of Stars	10 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:

- One star provides energy to our entire solar system.
- Sunspots
- Stars are born and stars die

Anchoring Activity:

- Formation of Solar System
- Marshmallow Fusion activity
- How does the mass of a star affect its life cycle?

Essential Questions:

- How does nuclear fusion create energy for the Sun?
- How does the Sun's energy reach the Earth?
- What is responsible for changes in the amount of radiation from the Sun?
- How do life cycles of stars differ?
- What is nucleosynthesis?

Enduring Understandings

- Our solar system contains the Sun which undergoes nuclear fusion in its core releasing radiation. This process provides the energy that heats the surface of the Earth. Once the hydrogen in its core is exhausted, the Sun will burn out. This will occur over a lifespan of approximately 10 billion years.
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- 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.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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.

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- HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements
- HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two ele

3-Dimensional Learning Components

Science and Engineering Practices	Disciplinary Core Ideas (DCI)	Crosscutting Concepts
Asking Questions and Defining Problems • Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. **Developing and Using Models** • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system.	**ESS1.A** • The Universe and Its Stars The star called the Sun is changing and will burn out over a lifespan of approximately 10 billion years. **PS3.D** • Energy in Chemical Processes and Everyday Life Nuclear Fusion processes in the center of the Sun release the energy that ultimately reaches Earth as radiation. **PS4.B** • Electromagnetic Radiation Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.	**Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. **Stability and Change** • Systems can be designed for greater or lesser stability. **Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math
- MP.2 Reason abstractly and quantitatively.

- MP.4 Model with Mathematics
- HSN-Q.A.1 Reason quantitatively and use units to solve problems - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN-Q.A.2 Reason quantitatively and use units to solve problems - Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3 Reason quantitatively and use units to solve problems - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSA.SSE.A.1 Seeing Structure in Expressions » Interpret the structure of expressions - Interpret expressions that represent a quantity in terms of its context.
- HSA.CED.A.2 Creating Equations- Create equations that describe numbers or relationships. - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- HSA.CED.A.4 Creating Equations- Create equations that describe numbers or relationships. - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

ELA

- RST.11-12.1 Science and Technical Subjects- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- SL.11-12.4 Speaking and Listening - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
- WHST.9-12.2 Text Types and Purposes - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

Computer Science and Design Thinking

- 8.2.12.C.4 Explain and identify interdependent systems and their functions.
- 8.2.12.C.2 Analyze a product and how it has changed or might change over time to meet human needs and wants.

Career Readiness, Life Literacies, and Key Skills

- 9.3.ST.2 Use technology to acquire, manipulate, analyze, and report data.
- 9.3.ST-ET.2 Display and communicate STEM information
- 9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.

Social-Emotional Learning Competencies

- **Self Awareness:** The abilities to understand the perspectives of and empathize with others, including those from diverse backgrounds, cultures, & contexts.

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- **Self Management:** The abilities to manage one's emotions, thoughts, and behaviors effectively in different situations and to achieve goals and aspirations.

Learning Targets	Investigations/Resources	Formative Assessment

Develop a model to identify and describe the relevant components of the solar system, including:
• Sun's place at the center;
  ○ hydrogen as the Sun's fuel;
  ○ Helium and energy as the products of fusion processes in the sun; and
  ○ That the Sun, like all stars, has a life span based primarily on its initial mass, and that the Sun's lifespan is about 10 billion years.
 	
In the model, students describe relationships between the components, including the process of radiation, and how energy released by the Sun reaches Earth's system.
	Diameter of the Sun Lab
	Popcorn Fusion Lab- Resources in folder
	Fusion Analogy Map
	Sunspot Graphing Lab
		• Formation of Solar System Activity: sequence the events in the formation of our solar system with the Sun at the center.
		• Create their own definition of nuclear fusion after watching YouTube video.
		• Sunspot & Climate Activity: graph sunspot numbers over the past 400 years and explain how the Maunder Minimum was responsible for a mini ice age on Earth.
		• Describe how the radiometer hand held device is evidence of Sun's energy transfer.

Communicate the relationships between the life cycle of the stars, the production of elements, and the conservation of the number of protons plus neutrons in stars in two different formats. Identify that atoms are not conserved in nuclear fusion, but the total number of protons plus neutrons is conserved. Describe that: • Helium and a small amount of other light nuclei (i.e., up to lithium) were formed from high-energy collisions starting from protons and neutrons in the early universe before any stars existed.	• H-R diagram • H-R diagram Gizmo • Sunlike Star Graph • Cosmic Connections- like it but it never flows well; more on presentation • Marshmallow Fusion Activity • Parallax Activity • Lots of notes in the folder. I don't know what we need	Draw and label the stages in each of the three life cycles of stars based on mass. For each stage in the star's cycle, include a cross sectional diagram labeling the elements produced. On a periodic table identify and describe the trends of elements (1) formed before stars existed, (2) in the stars, and (3) formed in supernova explosions. Include a color coded key.

• More massive elements, up to iron, are produced in the cores of stars by a chain of processes of nuclear fusion, which also releases energy. • Supernova explosions of massive stars are the mechanism by which elements more massive than iron are produced. There is a correlation between a star's mass and stage of development and the types of elements it can create during its lifetime. • Electromagnetic emission and absorption spectra are used to determine a star's composition, motion and distance to Earth.		

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Develop a model and explain the Sun's life span according to surface temp (k)and luminosity (H-R diagram)	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.
• Referring to a periodic table of elements, write an essay explaining how the following elements formed. i. helium and lithium ii. elements through iron iii. elements more massive than iron	

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Unit Title	**Time Frame/Pacing**
Big Bang Theory	4-5 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Anchoring Phenomena:
- Certain stars appear more blue or more red than they should

Anchoring Activity/Question:
- Have students demonstrate the effects of Doppler Effect.

Essential Question:
- How do you know if something is still expanding?
- How is the frequency of light leaving an object affected by its velocity?

Enduring Understandings

- The light spectra of a star is used to identify its composition, movement, and distance from Earth.
- Evidence for the Big Bang theory includes the observation of distant galaxies receding from the Milky Way, the amount of gases in stars and in space, and maps of cosmic background microwave radiation in the universe.
- Hydrogen and helium formed at the time of the Big Bang. Elements with atomic nuclei lighter than iron are produced in the stars. Elements with nuclei greater than iron form as a result of supernova explosions.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- 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.

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts**
Developing and Using Models • Develop and use a model based on evidence to illustrate the relationships	**ESS1.A** • The Universe and Its Stars The study of stars' light spectra and brightness is used to	**Systems and System Models** • When investigating or describing a system, the boundaries and initial

between systems or between components of a system. **Obtaining, Evaluating, and Communicating Information** • Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	identify compositional elements of stars, their movements, and their distances from Earth; The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.; 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.	conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. **Stability and Change** • Systems can be designed for greater or lesser stability. **Energy and Matter** • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- HSN-Q.A.1 Reason quantitatively and use units to solve problems - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN-Q.A.2 Reason quantitatively and use units to solve problems - Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3 Reason quantitatively and use units to solve problems - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSA.SSE.A.1 Seeing Structure in Expressions » Interpret the structure of expressions - Interpret expressions that represent a quantity in terms of its context.
- HSA.CED.A.2 Creating Equations- Create equations that describe numbers or relationships. - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- HSA.CED.A.4 Creating Equations- Create equations that describe numbers or relationships.- Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R.

ELA

- RST.11-12.1 Science and Technical Subjects - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- WHST.9-12.2 Text Types and Purposes- Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

Computer Science and Design Thinking

- 8.2.12.C.2 Analyze a product and how it has changed or might change over time to meet human needs and wants.

Career Readiness, Life Literacies, and Key Skills

- 9.3.ST.2 Use technology to acquire, manipulate, analyze, and report data.
- 9.3.ST-ET.2 Display and communicate STEM information.
- 9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.

Social-Emotional Learning Competencies

- **Self Management:** The abilities to manage one's emotions, thoughts, and behaviors effectively in different situations and to achieve goals and aspirations.
- **Responsible Decision-Making**: The abilities to make caring and constructive choices about personal behavior and social interactions across diverse situations.

Learning Targets	Investigations/Resources	Formative Assessment
Construct an explanation of how astronomical evidence is used collectively to support the Big Bang theory, which states that the universe is expanding, thus it was hotter and denser in the past, and that the entire visible universe emerged from a very tiny region and expanded. Identify and describe the evidence to construct the explanation, including: • The composition (hydrogen, helium and heavier elements) of stars; • The hydrogen-helium ratio of stars and interstellar gases;	• Spectroscopy Lab/Gas tubes with special glasses • Formation of of Elements in the Stars Essay/Article Template • Cosmic Times • Catch the Waves and Making Waves • Project Spectra- 2 Labs • Spectroscopy Virtual Lab • Doppler Effect Worksheet- contains good links • Hubble's Law Gizmo	**Formative:** • Discover the relationship between wavelength and frequency and the speed of light using the EM spectrum. • Identify in the elements in the stars based on their spectra • Prove that the universe is expanding (exit ticket) • Research the story behind the discovery of cosmic background radiation and how this evidence supports the Big Bang Theory • Develop a timeline of the Big Bang theory including dates and explanations.

• The redshift of the majority of galaxies and the redshift vs. distance relationship; and • The existence of cosmic background radiation.		
Describe the source of the evidence and the technology used to obtain that evidence. Use reasoning to connect evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct the explanation for the early universe (the Big Bang theory). Describe the following chain of reasoning for their explanation: • Redshifts indicate that an object is moving away from the observer, thus the observed redshift for most galaxies and the redshift vs. distance relationship is evidence that the universe is expanding. • The observed background cosmic radiation and the ratio of hydrogen to helium have been shown to be consistent with a universe that was very dense and hot a long time ago and that evolved through different stages as it expanded and cooled. • An expanding universe must have been smaller in the past and can be extrapolated back in time to a tiny size from which it expanded.		

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking

more complex questions and exploring concepts in greater depth.	
Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• **Summative:** Use reasoning to construct an explanation of how the four pieces of evidence support the Big Bang Theory.	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.

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Unit Title	**Time Frame/Pacing**
Orbital Motion of Space	4 weeks

Phenomena/Anchoring Activity/Anchoring Question/Essential Questions

Phenomena:
- Natural and Man-made satellites currently orbit the Earth without falling down.
- In 2001, the Mir space station fell out of orbit and returned to Earth.

Anchoring Activity/Question:
- PhET simulation of Kepler's Laws

Essential Questions:
- What do Kepler's Laws explain?
- How do satellites stay in orbit?

Enduring Understandings

- Kepler's Laws and Newton's Gravitational and Third Law predict the motion of orbiting objects in the solar system which can be applied to human-made satellites as well as planets and moons.

NJ Standards/NGSS Performance Expectations Taught and Assessed
Students who demonstrate understanding can:

- HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
- HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.]

3-Dimensional Learning Components

Science and Engineering Practices	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts**
Planning and Carrying Out Investigations • Plan and conduct an investigation	**ESS1.B** • Earth and the Solar System Kepler's Laws describe common features of the motions	**Systems and System Models** • When investigating or describing a system, the boundaries and initial

individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Using Mathematics and Computational Thinking** • Create a computational model or simulation of a phenomenon, designed device, process, or system. **Constructing Explanations and Designing Solutions** • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	of orbiting objects, including their elliptical paths around the Sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. **PS2.B: Types of Interactions** • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5)	conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. **Stability and Change** • Systems can be designed for greater or lesser stability. **Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Interdisciplinary Connections: Math, ELA, and Computer Science and Design Thinking

Math

- MP.2 Reason abstractly and quantitatively.
- HSN-Q.A.1 Reason quantitatively and use units to solve problems - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN-Q.A.2 Reason quantitatively and use units to solve problems - Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3 Reason quantitatively and use units to solve problems - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSA.SSE.A.1 Seeing Structure in Expressions » Interpret the structure of expressions - Interpret expressions that represent a quantity in terms of its context.
- HSA.CED.A.2 Creating Equations- Create equations that describe numbers or relationships. - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- HSA.CED.A.4 Creating Equations- Create equations that describe numbers or relationships. - Rearrange formulas to highlight a quantity of interest,

using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. 8.2.12.B.4 Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.

ELA

- RST.11-12.1 Science and Technical Subjects - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- WHST.9-12.2 Text Types and Purposes - Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

Computer Science and Design Thinking

- 8.2.12.C.5 Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.

Career Readiness, Life Literacies, and Key Skills

- 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data.
- 9.3.ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.
- 9.3.ST-ET.5 Apply the knowledge learned in STEM to solve problems.
- 9.3.ST-SM.3 Analyze the impact that science and mathematics has on society.

Social-Emotional Learning Competencies

- **Self Awareness:** The abilities to understand one's own emotions, thoughts, and values and how they influence behavior across contexts.
- **Self Management:** The abilities to manage one's emotions, thoughts, and behaviors effectively in different situations and to achieve goals and aspirations.
- **Responsible Decision-Making:** The abilities to make caring and constructive choices about personal behavior and social interactions across diverse situations.

Learning Targets	Investigations/Resources	Formative Assessment
Use mathematical or computational representations of orbital motion: • The trajectories of orbiting bodies, including planets, moons, or human-made spacecraft; each of which depicts a revolving body's	• Gravity and Orbits Lab • Kepler Lab Resources • Circular motion applications - centripetal force, concept of inertia (N1L); could get	• Gravity and Orbits Lab • Kepler's Law of Planetary Motion Activity • Solar System Gizmo- Kepler wrap-up?

eccentricity (Kepler's first law of planetary motion); • planetary motion (an orbiting body sweeps out equal areas in equal time) to predict the relationship between the distance between an orbiting body and its star, and the object's orbital velocity (Kepler's second law of planetary motion); • the square of a revolving body's period of revolution is proportional to the cube of its distance to a gravitational center ($T2 \propto R$ (Kepler's third law of planetary motion).	in to the concept of weight (gravitational force due to the planet) • Kepler's Laws intro. activity • Orbital Motion- Kepler's Laws	
Use Newton's law of gravitation plus his third law of motion to predict how the acceleration of a planet towards the sun varies with its distance from the sun. Argue qualitatively about how this relates to the observed orbits.	• PhET Gravity Force Lab - shows relationship(s) for universal gravitation • Using a Graph to Represent Kepler's 2nd Law • Satellite Motion and Kepler's 3rd Law Lab	

Instructional Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)

Individual accommodations and modifications in students' IEP and 504's will be followed and adhered to. Along with this:

- Group work and projects in this unit will be designed to allow the struggling learners to scaffold their learning and develop skills for working on larger projects by breaking down tasks. All students will be given opportunities to use different learning modalities to advance their understanding using varied strategies that accentuate their own learning style. Gifted learners will have the opportunity to challenge their problem solving skills by asking more complex questions and exploring concepts in greater depth.

Common Assessment(s)	**Assessment Modifications and/or Accommodations (ELL, Special Education, Gifted, At-Risk of Failure, 504)**
• Students will use Kepler's Laws to predict orbital path, relative orbital speed, and orbital period using mathematical representations. They will provide their reasoning for the path of solar system bodies using Newton's Laws.	• All assessments will be modified in accordance with specifications from CST as enumerated in each student's educational plan. This may include, but is not limited to, extra time, clarification of questions, reading questions aloud, word banks, and alternate testing sites.