NEW MILFORD PUBLIC SCHOOLS

New Milford, Connecticut

Honors Integrated Science

February 2020

BOE Approved June 2020

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New Milford's Mission Statement

The mission of the New Milford Public Schools, a collaborative partnership of students, educators, family and community, is to prepare each and every student to compete and excel in an ever-changing world, embrace challenges with vigor, respect and appreciate the worth of every human being, and contribute to society by providing effective instruction and dynamic curriculum, offering a wide range of valuable experiences, and inspiring students to pursue their dreams and aspirations.

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Honors Integrated Science

Grade 9

The Integrated Science course involves the study of major Earth science concepts with an emphasis on the environment. Areas of study include properties of stars, the Big Bang, cycling of matter, tectonic processes and Earth's history, pollution, energy sources and resource management. Science process skills and inquiry are stressed throughout. Students are encouraged to consider the real-world application of Earth science concepts. Study skills and organizational ability are stressed by means of reading assignments, homework, modeling, lab reports and group discussions. At the honors level, this course involves additional independent readings at a higher reading level, more mathematical computations and analysis, and requires more in depth analysis and critical thinking in regards to data.

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Pacing Guide

Units	Number of Blocks
Unit 1: Big Bang and Spectroscopy	6 blocks
Unit 2: The Sun and Energy	8 blocks
Unit 3: Lives of Stars	7 blocks
Unit 4: Solar System Formation	7 blocks
Unit 5: Earth’s Formation and Early History	7 blocks
Unit 6: Earth’s Internal Energy	8 blocks
Midterm Exam	
Unit 7: Earth’s Changing Surface	8 blocks
Unit 8: Water as a Resource	8 blocks
Unit 9: Life Transforms Earth - Carbon and Carbon Resources	9 blocks
Unit 10: Solar Energy and the Atmosphere	8 blocks
Unit 11: Climate Change and the Future	8 blocks
Final Exam	

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Unit 1: The Big Bang and Spectroscopy - Stage 1 Desired Results

ESTABLISHED GOALS

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

RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Transfer

Students will be able to independently use their learning to…

- SEP 4 - Analyze and interpret data
- SEP 5- Use mathematical and computational thinking
- SEP 6 - Construct explanations
- SEP 7 - Engage in argument from evidence

Meaning

UNDERSTANDINGS

Students will understand that…

- ESS1.A
  - The study of stars' light spectra and brightness is used to 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 that universe.

ESSENTIAL QUESTIONS

Students will keep considering…

- How can we explain our universe and how it came to be?
- What types of energy are at work in the universe around us?

	● PS4.B ○ 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.	
	Acquisition	

	Students will know… ● Electromagnetic radiation travels through space and carries energy and information with it. ● Electromagnetic radiation is divided into a spectrum of 7 different classifications that are organized based on the amount of energy of the wave, but all EM waves travel at the speed of light through space. ● Light spectra from distant objects can provide information about composition, temperature, and line of sight velocity (Doppler Effect). ● The Big Bang occured 13.8 billion years ago based on evidence from light from distant galaxies, abundance of elements in the universe and cosmic microwave background radiation. ● that Hubble's Law is the mathematical relationship between the distance of a galaxy and its velocity away from Earth. ● CCC (Cause and Effect): the relationship between motion of objects and wavelength change in the spectra ● CCC (Patterns): Spectra are patterns we observe though light emission/absorption from different elements present.	*Students will be skilled at…* ● Explaining The Big Bang Theory and supporting it by using evidence found within the universe. ● Evaluating within the visible light spectrum to determine different elements present in an object that is emitting light. ● Illustrating the movement of objects within the universe (Doppler Effect) using the visible light spectrum ● Appling Hubble's Law to make predictions about distance and/or speed of a receding galaxy.

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T,M,A	Constructed response rubric to assess for claim accuracy, appropriate evidence, and reasoning that connects to content accurately.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* The types of information that can be observed through studying the spectra of light emitting objects and how that evidence can be used to support the Big Bang Theory **Goal:** To study objects within the Universe and explain how scientists can determine composition and line of sight velocity of light emitting objects and how that information could be used to support the theory of the Big Bang. **Role:** Students will act as an astronomer and evaluate data and observations presented to them in order to describe the properties of a light emitting object. **Audience:** Visitors to the JJ McCarthy Observatory **Situation:** While using the telescope at JJMO, you come across a new light emitting object (galaxy) and analyze the spectral data to determine its composition and motion within the Universe and use that information to support the Big Bang Theory to present to fellow astronomy enthusiasts. Analyze the spectral data to determine its composition and motion within the Universe and use that information to support the Big Bang Theory **Products and Performance:** Constructed Response/Report **Standard for Success:** Rubric

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Quizzes on content ● Questions on activities and projects ● Verbal questions for comprehension ● End of unit assessment
M,A	**Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R)	
T,M,A	**Expanding Balloon Activity (Honors Version)** - Graph and analyze data related to the expansion of the Universe using a balloon as a model (H,E1,R,T)	
M,A	**Spectral Analysis and Classification Activity** - Analyze given spectra to determine object composition and create unique spectra based on composition of light emitting objects (W,E1,T,O)	
T,M,A	**Doppler Effect Activity** - Analyze given spectra and explain the impact of the Doppler Effect on them. Create spectra of moving objects based the Doppler Effect (W,E1,T,O)	
A, M, T	**Hubble's Law:** Graphing data from distant galaxies to determine the distance and speed, and then interpolate and link back to support the Big Bang Theory. (W, E1, T, O)	

Unit 2: The Sun and Energy - Stage 1 Desired Results

ESTABLISHED GOALS

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

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Transfer

Students will be able to independently use their learning to…

- SEP 2 - Develop and use models
- SEP 4 - Analyze and interpret data
- SEP 5- Use mathematical and computational thinking
- SEP 6 - Construct explanations
- SEP 7- Engage in argument from evidence

Meaning

UNDERSTANDINGS

Students will understand that…

- ESS1.A
  - The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.
- PS3.D
  - Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.

ESSENTIAL QUESTIONS

Students will keep considering…

- Which processes are involved in the creation, movement and transformation of matter and energy from the core of the sun to Earth?

	Acquisition	
	Students will know… ● The names and order of the six main layers of the sun. ● The type of radiation produced in the core of the sun. ● How the random walk of a photon determines the energy, wavelength, and residence time of a photon as it makes its way out of the sun. ● How long it takes a photon to reach Earth once it emerges from the surface of the sun. ● Nuclear fusion is the process which occurs in stars that is responsible for generating energy and creating elements heavier than hydrogen within their cores. ● Solar winds occur when matter is expelled from the sun and interacts with our atmosphere and environment. ● CCC (Scale, Proportion, and Quantity) understanding that a seemingly small reaction can generate relatively large amount of energy ● CCC (Energy and Matter) understanding how energy is made from matter, and moves from the core to surface of star and then flows out to space ● The forces that occur in the core of the sun and how those forces relate to nuclear fusion. ● Know how much energy is created from a fusion reaction of a star.	*Students will be skilled at…* ● Illustrating the path of a photon as it is created in the sun's core and eventually reaches Earth, and evaluating the changes in properties of that photon throughout its journey. ● Describe the process of nuclear fusion and support it with criteria that allow for the process to occur. ● Explain how solar winds impact Earth's systems ● Modeling the structure of the sun with details including: equilibrium, forces, EMR produced and changes that occur. ● Calculating the amount of energy created from a nuclear reaction.

Unit 2: The Sun and Energy - Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T, M, A	Constructed response rubric to assess for claim accuracy, appropriate evidence, and reasoning that connects to content accurately	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* The processes that generate energy in stars and the factors which affect the habitability of planets in the Kepler 62 system in regards to a potential colonization effort. (Honors version includes additional computations and mathematical analysis) **Goal:** Determine the habitability of planets in the Kepler 62 system utilizing understanding of the processes of nuclear fusion and solar winds **Role:** Planetary Scientist **Audience:** NASA's Colonization Committee **Situation:** You have been asked to evaluate a new star system for potential habitability. **Products and Performance:** CER, Diagram and written report **Standard for Success:** Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* A, M Summative Assessments M, T Questioning of Students A, M, T Warm-up and Exit tickets A, M, T In-class Activities and Projects

Unit 2: The Sun and Energy - Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Quizzes on content ● Questions on activity and projects ● Verbal questions for comprehension ● End of Unit assessment
M,A	**Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R)	
T, M, A	***Random Walk Activity:*** Collect and analyze the path of a photon from its creation in the core of the sun to exiting the radiative zone and identify the relationship between residence time, energy, and wavelength changes that photon goes through (H,E1,E2,O)	

T ,M, A	***Nuclear Fusion: Process and Analysis:*** Model the process of nuclear fusion within the core of the sun and explain how heavier elements form (W,E1,E2,T,O)	
T, M, A	***Model Solar Interior:*** Model energy generated in the core, exiting the sun and reaching Earth (W,E1,R,T,O)	
T, M	***Solar Winds/Space Weather:*** Describing what space weather is, how it is created and the impact it has on the Earth systems (H,R,E2,O)	
A, M T	***Nucleosynthesis:*** Analyze and calculate mass defect using $E = mc^2$ and to identify the different stages of proton-proton fusion. (W, E1, T)(W, H, E1, E2, T)	
M, T	***Solar Activity Cycles (sunspots):*** Calculate and analyze patterns of sun spot activity and develop a connection to its impact on Earth systems. (E1, T)	

Unit 3: The Lives of Stars - Stage 1 Desired Results

ESTABLISHED GOALS

HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Transfer

Students will be able to independently use their learning to…

- SEP 1- Ask Questions
- SEP 2 - Develop and use models
- SEP 4 - Analyze and interpret data
- SEP 6 - Construct explanations

Meaning

UNDERSTANDINGS

Students will understand that…

- ESS1.A
  - Other than 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.

ESSENTIAL QUESTIONS

Students will keep considering…

- What are stars and how do their different physical properties determine how they go through their life cycles?

	Acquisition	
	Students will know… ● The various types of stars (low, high, and very high mass) and their developmental stages. ● The elements created within stars during various stages of their lives. ● What forces are in equilibrium in a stable star and what happens when those forces go out of balance. ● What apparent and absolute magnitude are and how they differ. ● CCC (Stability and Change): understanding what makes a star stable and what makes it undergo change during its life cycle. ● CCC (Cause and Effect): the stages of stars are a series of cause and effect relationships.	*Students will be skilled at…* ● Explaining how and why stars of different masses go through different developmental stages in different amounts of time. ● Describing the relationship between mass, luminosity, surface temperature,and color of a star. ● Utilizing an H-R diagram to make predictions about masses, life cycles and stages of development of stars ● Measuring and analyzing the brightness of a light emitting object and explaining how distance affects the intensity of light received. ● Calculating apparent magnitudes of stars

Unit 3: The Lives of Stars - Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T, M, A	Rubric assessing content accuracy, format, and presentation of materials.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* The various types of stars, their developmental stages, and the reasoning behind the observed differences in the life cycles of stars of different masses.. **Goal:** Research known properties of a particular star and use that knowledge to develop a report that outlines the star's life cycle (from its creation to its death) and its current stage of development **Role:** Astronomer at JJMO **Audience:** JJMO VIsitors **Situation:** You are an astronomer at the observatory who is creating a catalog of well-known stars for the visitors to the observatory **Product or Performance:** Catalog Entry for Assigned Star **Standards for Success:** Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Quizzes and Tests ● Formative assessments ● Lab analysis and reflection on results ● Warm-ups and exit tickets ● Article readings/summaries ● Homework assignments

Unit 3: The Lives of Stars - Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Quizzes on content ● Questions on activity and projects ● Verbal questions for comprehension ● End of Unit assessment
M,A	**Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R)	
T,M,A	***Lab: Inverse Square of Light:*** Measure and analyze the brightness of a light emitting object and explain how distance affects the intensity of light received (H,E1,R,E2)	
M,A	***Life Cycles of Stars:*** Construct a timeline of developmental stages and compare/contrast the life cycle of stars of varying	

T,M,A	masses (W,E1,T,O) ***H-R Diagram: Evaluation and Analysis:*** Plot and analyze a variety of stars based on temperature and luminosity, identify trends and describe how those trends identify stars of different masses and different stages of their lives (W,E1,E2T,O)	

Unit 4: Formation of the Solar System - Stage 1 Desired Results

ESTABLISHED GOALS

HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Transfer

Students will be able to independently use their learning to…

- SEP 2- Develop and Use Models
- SEP 4 -Analyze and interpret data
- SEP 5 -Use mathematics and computational thinking
- SEP 6 -Construct explanations

Meaning

UNDERSTANDINGS

Students will understand that…

- ESS1.B
  - Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects form, or collisions with, other objects in the solar systems

ESSENTIAL QUESTIONS

Students will keep considering…

- How can studying our solar system today help us understand how it, and our planet, formed?
- Why do scientists study other solar systems?

	Acquisition	
	Students will know… ● The stages of a solar system's development and the planetary objects present at each stage. ● The 8 planets within our solar system, their classification, and location within our solar system. ● The differentiation of materials within the solar system as it relates to temperature, solar wind, and planetary formation. ● Kepler's 3 laws of planetary motion and the law of universal gravitation. ● Kepler's 1st and 2nd law determine the rate of velocity of objects orbiting around other objects. ● CCC (Patterns) - identify patterns within classes of planets and in orbital data ● CCC(System and System Models) defining the system and creating a model to show understanding.	*Students will be skilled at…* ● Constructing an argument to support the nebular condensation theory utilizing observed evidence. ● drawing a model of the stages of solar system formation ● Describing the role eccentricity plays in understanding a planet's orbital velocity, orbital period, temperature ranges, and strength of the force of gravity. ● Inferring planets' features and composition based on their distance from the sun. ● Describing the role gravity plays in regards to mass and distance between two objects. ● Inferring based on Kepler's 1st and 2nd laws the relationship between different parts of a planet's orbit and the area that is covered within that period. ● Inferring within Kepler's 3rd law the relationship between distance and orbital period of a planet. ● Calculating the eccentricity of orbits ● Calculating the orbital properties of planets using Kepler's 3rd Law ● Calculating the changes in the strength of the force of gravity between two objects

Unit 4: Formation of the Solar System - Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T,M,A	Constructed response rubric to assess for claim accuracy, appropriate evidence, and reasoning that connects to content accurately.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* How Kepler's Laws of planetary motion and Universal Gravitation allow scientists to evaluate that properties of planets that orbit other stars **Goal:** To create a model of another star system and evaluate its planets' habiltibilities in the pursuit of finding suitable places for colonization. **Role:** NASA planetary science **Audience:** International Planetary Colonization Commission **Situation:** You have been asked to create a model of another solar system and to present the potential habitability of the planets in that system **Product or Performance:** Report with planetary orbital data, calculations, evaluation of which planets are in the habitable zone and a recommendation on whether to pursue colonization of the system **Standards for Success:** Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Quizzes and Tests ● Formative assessments ● Lab analysis and reflection on results ● Warm-ups and exit tickets ● Article readings/summaries ● Homework assignments

Unit 4: Formation of the Solar System - Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Quizzes on content ● Questions on activity and projects ● Verbal questions for comprehension ● End of Unit assessment
	Video: Introduction to the Solar System (Frank Gregorio) (H)	
M,A	**Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,R)	
T,M,A	***Solar Stew Activity:*** - plot planetary data to identify patterns of terrestrial and jovian planets and relate these patterns to how the solar system formed (R,E2,T,O)	
T,M,A	***Kepler's 1st Law and Ellipses Activity:*** model Kepler's 1st law of Motion, calculate eccentricity of model orbits and calculate orbital eccentricities of solar system objects (E1, R)	
T,M,A	***Kepler's 2nd Law Activity (Honons Version):*** use evidence to support Kepler's 2nd Law of Motion that planets cover equal area during orbits in equal amounts of time (E1, R)	
T,M,A	***Kepler's 3rd Law Activity (Honors Version):*** determine the mathematical relationship between orbital period and a	

A, M, T	planet's distance from the sun and calculate orbital properties of planets in the solar system using metric units and scientific notation (E1, R) **PhET Simulation- Gravity:** develop an understanding of the factors that affect the stability of planets around a star by manipulating distance between objects and masses.	

UbD Template 2.0

Unit 5: Earth's Formation and Early History - Stage 1 Desired Results

ESTABLISHED GOALS

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 early history

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics

RST.9-10.5 Analyze the structure of the relationships among

Transfer

Students will be able to independently use their learning to…

- SEP 1- Ask Questions
- SEP 4 -Analyze and interpret data
- SEP 5 -Use mathematics and computational thinking
- SEP 6 -Construct explanations

Meaning

UNDERSTANDINGS

Students will understand that…

- ESS1.C
  - Although active geologic processes, such as plate tectonics and erosion, have

ESSENTIAL QUESTIONS

Students will keep considering…

- What methods, objects, and features do scientists use to uncover the formation of the earth and other solar system objects?

<table>
<tr>
<td rowspan="3">concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.</td>
<td>destroyed or altered most of the very early rock records 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
○ 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.</td>
<td></td>
</tr>
<tr>
<td colspan="2">Acquisition</td>
</tr>
<tr>
<td>Students will know…
● the stages of Earth’s Formation
● the role craters play in relative dating of solar system bodies
● how radioactive elements are used in absolute dating of Earth and other solar system bodies
● The mathematical trend of half lives
● CCC (Energy and Matter): Matter and energy had flowed into Earth’s system.
● CCC (Cause and Effect): how to identify the events that caused Earth to develop into its present state.</td>
<td>Students will be skilled at…
● using relative dating in reference to craters size, layering, and factors that have altered their appearance to justify the age of a planetary object.
● Calculating the age of a planetary object using absolute dating in reference to predictable stable half lives.
● Perform multi-step calculations to determine absolute ages of various Earth materials when given limited information
● Summarize the stages of Earth’s formation, including the formation of the Moon, Heavy Bombardment, differentiation of the internal layers of Earth, and formation of Earth’s magnetic field</td>
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Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T,M,A	Rubric focusing on content, format, and calculations.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* Ages of regions of different solar system object's surfaces based on various factors such as crater density, overlapping features and radiometric dating of materials. **Goal:** To estimate the ages of two different regions on the surface of Mars by using a variety of dating methods. **Role:** Astronomy Magazine Contributor **Audience:** Astronomy Magazine Readers **Situation:** You are tasked with writing a response to a question posed by a reader about how planetary scientists are able to determine the ages of surfaces of solar system objects without ever actually visiting them. **Product of Performance:** CER, Written Response, specific multi-step calculations and crater density analysis **Standards for Success:** Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Quizzes and Tests ● Formative assessments ● Lab analysis and reflection on results ● Warm-ups and exit tickets ● Article readings/summaries ● Homework assignments

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Quizzes on content ● Questions on activity and projects ● Verbal questions for comprehension ● End of Unit assessment
M,A	**Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R)	
M,A	***Crater Density Activity:*** Analyze the relationship between crater density and size and age of a surface. Apply this knowledge when determining the relative age of planetary objects (W,H,E1,E2)	
T,M,A	***Lab: Radiometric dating and Half-Life:*** Model the process of radioactive decay to calculate half-lives of elements (E1,R,E2,O)	
T,M,A	***Radiometric Dating of ET Materials Activity:*** Use Radiometric ages of various rock material to determine the age of Earth (W,H,R,E2,O)	
M,A	***Radiometric Dating Calculations***: Perform a series of calculations to determine the ages of objects when given limited information (E1, E2, T, O)	

Unit 6: Earth's Internal Energy - Stage 1 Desired Results

ESTABLISHED GOALS

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-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

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

RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

RST.9-10.5 Analyze the structure

Transfer

Students will be able to independently use their learning to…

- SEP 1- Ask Questions
- SEP 2- Develop and use models
- SEP 4- Analyze and Interpret Data
- SEP 6- Construct explanations

Meaning

UNDERSTANDINGS

Students will understand that…

- ESS1.C
  - Continental rocks, which can be older than 4 billion years old, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.
- ESS2.A
  - 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

ESSENTIAL QUESTIONS

Students will keep considering…

- Can we justify our Earth's internal structure without visibly observing it?
- How can the surface of our planet give us insight into the inner processes that helped shape the continents and oceans we know today?

of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).	core, a liquid core, a solid mantle and crust. Motions of the mantle and its plate 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 is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a coherent account of its geological 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. ● PS4.A ○ Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet	
	Acquisition	
	Students will know… ● The theory of continental drift and the evidence used to support it.	*Students will be skilled at…* ● Justifying the differing ages of plates by using observable features on Earth.

	● The theory of plate tectonics and the evidence used to support it. ● The 3 different boundaries we find on the surface of the earth and the features related to them. ● The different waves created by earthquakes ● The layers of the earth and their features ● CCC (Energy and Matter) - explain the connection between Earth's internal energy and the movement of matter within and on the Earth's surface ● CCC (patterns): the energy moving through Earth's crust follows a predictable and understandable pattern that can be used to locate earthquakes and determine Earth's interior. ● CCC (Scale, Proportions and Quantity) tectonic plates move at a geologic rate, but within this time, plates move at different speeds	● CCC (Cause and Effect) explaining the process of subduction as it relates to convection currents and the impact on plate boundaries ● Justifying plate motion by utilizing evidence found within and on Earth. ● Interpreting data from seismic waves to justify Earth's internal structure. ● Utilize seismic wave data to visualize the process of subduction ● Summarizing the types of geologic hazards that occur at each type of plate boundary and explain why those hazards occur based on relationships between mantle convection and plate interactions

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
TMA	Rubric to assess model accuracy, content, and display.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* How different plate boundaries produce geologic hazards that present challenges to people living in that area and the processes that cause these challenges. **Goal**: To create a three-dimensional model of the geologic processes and features associated with a particular region on Earth and describe the possible effects on human settlements in that region **Role**: Geologist / Education Consultant **Audience**: Visitors to the Museum of Natural History in New York **Situation**: You have been asked to develop a three-dimensional model of a particular region on Earth which will be part of a new exhibit on geologic features and the benefits and risks associated with living in particular regions on Earth. **Product/Performance**: Three-dimensional Model/diorama with written components on Poster or Presentation/Slide Show, etc. **Standards for Success**: Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Quizzes and Tests ● Formative assessments ● Lab analysis and reflection on results ● Warm-ups and exit tickets ● Article readings/summaries ● Homework assignments

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Quizzes on content ● Questions on activity and projects ● Verbal questions for comprehension ● End of Unit assessment
M,A	**Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R)	
M,A	***Wegener's Puzzling Evidence:*** Analyze fossil evidence and geologic features to recreate Pangea (W,H,E1,T,O)	
T,M,A	***Atlantic vs. Pacific Plate Motion Activity (Honors Version):*** Calculate the rate of seafloor spreading in the Atlantic and Pacific oceans using the mid-ocean ridge and hot spots then compare and contrast the relative motions of the plates through geologic time(E1,R,T,O)	
M,A	***Exploring Plate Boundaries:*** Students are given pictures of different plate boundaries and asked to identify what type of boundary is represented in the diagrams, describe the boundary, and provide an example. (E1,R,E2,T)	
M,A	***Andes Subduction Boundary Activity*:** Students map the locations of earthquakes along the plate boundary between the Pacific Ocean and South America in order to visualize the process of subduction (WHERETO)	

M	***Mantle Convection:*** demonstration of convection currents and modeling activity for students to show Earth's interior (W,E1,R,E2,T,O)	
T,M,A	***Seismic Waves and Earth's Internal Structure (Honors Version):*** graph P and S wave data and use to infer the internal structure of Earth (E1,R,O)	

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Unit 7: Earth's Changing Surface - Stage 1 Desired Results

ESTABLISHED GOALS

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.

HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Transfer

Students will be able to independently use their learning to…

- SEP 3 - Plan and carry out investigations
- SEP 4 - Analyze and interpret data
- SEP 8 - Obtain, evaluate, and communicate information

Meaning

UNDERSTANDINGS

Students will understand that…

- ESS2.A
  - Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

ESSENTIAL QUESTIONS

Students will keep considering…

- How is our environment shaped by water?

<table>
<tr>
<td rowspan="4">RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.</td>
<td colspan="2">● ESS2.C
○ The abundance of liquid water on Earth’s surface and its unique combination of physical and chemical properties are central to the planet’s dynamics. These properties include water’s exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.</td>
</tr>
<tr>
<td colspan="2">Acquisition</td>
</tr>
<tr>
<td>Students will know…
● The difference between Physical and Chemical weathering, examples of each, and the environments where they are most common.
● Surface area of materials is an important factor in the rate at which they physically and chemically weather
● The pH scale and where acids, bases, and neutrals fall on that scale.
● Neutralization reactions occur between acids and bases and result in the production of water and neutral salts
● Erosion is the process of moving material and has 4 agents.
● Weathering is the process of breaking down material.
● That watersheds are divided by mountains.</td>
<td>Students will be skilled at…
● Identifying various properties of water (such as surface tension from cohesion or capillary action from adhesion) based on its polar structure
● Drawing a water molecule, labeling its components and charges and illustrating how hydrogen bonds form between adjacent water molecules
● Using an area's climate (precipitation and temperature) to predict what type of weathering is dominant.
● Identifying how surface area plays a role in the speed of weathering.
● Calculating surface area index and explaining how it relates to the rate at which weathering occurs
● Identifying Acids vs Bases and how they interact with different Earth materials to</td>
</tr>
</table>

	● Sediment size that is deposited varies based on the speed of the body of water. ● Rivers can meander or form a delta depending on their position within a watershed. ● The physical and chemical properties of water are central to the planet's dynamics (shaping the landscape) ● CCC (Cause and Effect) The effect of precipitation (normal vs. acidic) on different types of materials ● CCC (Stability and Change) what factors controls the rate of change in shaping the surface of the planet.	cause weathering. ● Identifying the products and reactants in a neutralization reaction and explaining how this process relates to weathering. ● Mapping out watersheds based on divides and ocean basins. ● Identifying river features (meanders, deltas, etc) and predicting their location based on the slope of the land and speed of the water. ● Analyzing the size of sediments transported by water moving at various speeds and relating that to they types of surface features that form

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T,M,A	Lab Report Rubric assessing science inquiry skills.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* How the composition of a rock and the environment in which it resides determine the type and rate of weathering it will experience. **Goal:** To analyze which of 4 given rock samples will weather the slowest in an area with slightly acidic rain in order to build a statue. **Role:** Geologist **Audience:** Your local town council **Situation:** Your local town council would like to build a statue. They are aware that the rain in the area can be acidic and cause statues to break down. It is your job to test the 4 samples of rock for the statue to see which will weather the least. **Products and Performance:** Lab Report which includes: Procedural Steps (created in small groups), percent change calculations, Graphs of changes in mass and pH, A letter to the town council summarizing findings and recommendations. **Standard for Success:** Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* A,M Summative Assessments M,T Questioning of Students A,M,T Warm-ups and Exit Tickets A,M,T In-class Activities and Projects

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring
M,A	**Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R)	● Quizzes on content ● Questions on activities and projects ● Verbal questions for comprehension ● End of unit assessment
TMA	***Weathering and Climate Graph (Honors Version):*** Students will utilize a graph that displays how temperature and precipitation change the types of weathering that are dominant in that area. Students then research the climate of New Milford and make a prediction about what type of weathering	

	dominates here. (E1,T,O)	
A, M	**Lab:-Mechanical Weathering:** using chalk as a basic substance, investigating the impact of substances going through abrasion and the effect it has on shape and size of the material.	
MA	***Lab- Neutralization Reaction:*** Using chalk as a basic substance, model rates of chemical weathering that occur at different ph (various concentrations of acetic acid). Exploring why pH plays a role in the weathering of many Earth materials. (W,H,E1,T,O)	
MA	***pH Inquiry Activity:*** Make predictions about the pH of different household substances, then test those predictions and research what chemical components are present in each substance that makes them acidic or basic. (H,E1,O)	
MA	***Surface Water Features Activity (Honors Version):*** Analyzing different features created by running water, where they occur in a river system and how slope of land and water speed determine which features form. Identify features such as deltas, cut banks and point bars, and explain how and where in a river system they form (W,E1)	
A	***US River Watersheds Activity (Honors Version):*** Exploring various rivers in the United States to see where major divides and watersheds occur. Discuss potential impacts to the watershed from human activity. Calculate the slope, and therefore energy, of different parts of a river system.(W,R,E2,T,O)	
A	**Activity- Water Olympics:** perform several different tests focusing on different water properties and analyze the results. (W, H, E1, R, E2)	

<table>
<tr><th colspan="3">Unit 8: Water as a Resource - Stage 1 Desired Results</th></tr>
<tr><td rowspan="3">ESTABLISHED GOALS

HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text

RST.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy)</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…

● SEP 3 - Plan and carry out investigations
● SEP 4 - Analyze and interpret data
● SEP 8 - Obtain, evaluate, and communicate information</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS
Students will understand that…
● ESS3.C
○ The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
● ETS1.B
○ When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.</td><td>ESSENTIAL QUESTIONS
Students will keep considering…
● What is society's impact on water resources?
● How can society minimize our impact on water resources?</td></tr>
</table>

	Acquisition	
	Students will know… ● Fresh water is not evenly distributed and makes up a small portion of the water on earth. An even smaller portion of this freshwater is readily available on the surface of the earth. ● Pollution, depending on its location within a watershed, will affect the rest of that watershed until it ends at an ocean ● Aquifers are underground storage of water. Aquifers contain a zone of aeration and a zone of saturation that fluctuate based on factors that affect infiltration and can be affected by human usage ● The difference and connection between porosity and permeability ● The difference between point and nonpoint source pollution and examples of each ● CCC (Cause and Effect) Eutrophication from pollution disrupts bodies of waters' natural ecosystems leading to severe environmental impacts ● CCC (Cause and Effect): Many people have wells as their resource of water, and to understand the causal relationship to wells drying up. ● Governments create legislation to help reduce the impact of human activities on the quality of water resources	*Students will be skilled at…* ● Evaluating how runoff and infiltration are affected by human interference in the makeup of watershed surfaces ● Assessing where pollution has occurred within aquifers and how slope and location of pollution affects the aquifers and around it. ● Determining what materials would work best as an aquifer by evaluating their porosity and permeability ● Identifying and comparing sources of pollution as point vs nonpoint and correctly identifying what type of polluting agent is involved (biological, chemical, physical) ● Describing possible mitigation and remediation strategies for water pollution ● Evaluating potential well sites and making a recommendation about which site would be best to use ● To evaluate aquatic ecosystems to identify the level of eutrophication and the impact it can have on the ecosystem. Also, to identify the source/type of pollution causing the issue.

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
TMA	Rubric to assess content accuracy, format and presentation of materials	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* How to implement a technological solution that reduces impacts of human activities on water resources. **Goal:** To implement a technological solution that limits water pollution. **Role:** Developer **Audience:** Board of Directors **Situation:** You are looking to develop homes in an area but your board of directors wants to be sure that you will minimally impact the environment to avoid any future litigation. Design systems that interact with the local watersheds and aquifers with minimal impact. **Products and Performance:** Label Diagrams with appropriate placement, Written report to justify placement **Standard for Success:** rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* A,M Summative Assessments M,T Questioning of Students A,M,T Warm-ups and Exit Tickets A,M,T In-class Activities and Projects

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
MA TMA	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…* **Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R) **Analyzing Changes in Runoff of a Watershed Activity:** Analyze how a watershed has changed over 100 years to explore the effect human interference has in regards to runoff vs infiltration of surface water. Calculate changes in surface	Progress Monitoring ● Quizzes on content ● Questions on activities and projects ● Verbal questions for comprehension ● End of unit assessment

	type coverage and changes in runoff percentages over the 100 year period. (W, E1, E2, T)	
TMA	**Porosity and Permeability Lab (Honors Version):** Compare the porosity and permeability of four types of substrate to determine the best material for an aquifer. Map and identify aquifer structures and explain how porosity and permeability determine the best locations for wells. (W, E1, R, E2)	
MA	**Investigation of Water Pollution Related Illnesses in a Community:** Plot and analyze groundwater data to determine the source of pollution. Explain impact and possible remediation strategies. (W, H, E1, E2, T, O)	
A	**Groundwater Model Analysis:**Teacher uses a model to help students visualize parts of an aquifer, types of wells, and how those parts are affected during times of flooding, times of drought, or from point source pollution.(W, H, E1, R, T, O)	
A, M	**Modeling Eutrophication:** create a model showing the development of a body of water going through eutrophication. Analysis of the impact it has on the environment. (W, H, E1, R, T, O)	

Unit 9: Life Transforms Earth - Stage 1 Desired Results

ESTABLISHED GOALS

HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.

HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere and biosphere.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Transfer

Students will be able to independently use their learning to…

- SEP 2- Develop and Use Models
- SEP 3 - Plan and carry out investigations
- SEP 4 - Analyze and interpret data
- SEP 5 - Use Mathematics and Computational Thinking
- SEP 8 - Obtain, evaluate, and communicate information

Meaning

UNDERSTANDINGS

Students will understand that…

- **ESS2.A**
  - Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes (HS ESS2-2)
- **ESS2.D**
  - Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7)
- Changes in the atmosphere due to

ESSENTIAL QUESTIONS

Students will keep considering…

How do Earth's major systems interact?

How do living organisms alter Earth's processes and structures?

	human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) ● **ESS2.E** ○ The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual coevolution of Earth's surface and the life that exists on it. (HS.ESS2-7)	
	Acquisition	
	Students will know… ● The composition of the atmosphere has changed since the formation of Earth. ● CCC (Systems and Models) There are four spheres of Earth that are inter-connected, and changes in one can affect others. ● There are many processes that move carbon from one sphere by changing its form and keep carbon balanced at its current level ● CCC (Cause and Effect) The changes of gases have an effect on the atmosphere through the development of feedback mechanisms that can alter other systems. (Ozone and life formation on land) ● CCC (Stability and Change) that changing one sphere can impact other spheres in the carbon cycle,, and to identify the controls of the system that keep it balanced.	*Students will be skilled at…* ● Justifying claims using evidence. ● Describing the processes that move carbon through the different Earth system, and differentiating between short and long term processes. ● Explaining the complex set of feedbacks and interactions that occur between living things and Earth's systems that move carbon from sphere to sphere, changing the composition of the atmosphere and making the planet habitable for animals and humans ● Analyzing carbon data to calculate where carbon imbalances are occurring and identifying the processes causing the imbalances. ● Explaining how human impacts on the carbon cycle lead to changes in climate ● Elaborating where the sinks and reservoirs of carbon on the planet are and

	● There are many cycles, but the carbon cycle can affect weather, climate and other systems (such as acidification of the hydrosphere). ● Carbon has short term and long term storage processes that occur at different rates. ● Carbon is stored in sinks, or reservoirs, that can be impacted by natural and human activities.	how they shaped our planet from its formation to present time.

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
A, M, T	Writing Rubric to assess content accuracy, use of evidence as support, and writing skills	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* **Goal**: To evaluate several energy sources in terms of risks and benefits. **Role**: Energy Consultant (Green and traditional) **Audience**: Companies interested in switching to alternative energy sources as a way to reduce their carbon emissions.. **Situation**: Several companies within the state are interested in switching to alternative energy sources as a way to reduce their carbon emissions. Students will evaluate their options and present the best possible alternatives. **Product**: Cost-Benefit Analysis Presentation **Standard**: Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* A,M Summative Assessments M,T Questioning of Students A,M,T Warm-ups and Exit Tickets A,M,T In-class Activities and Projects

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Quizzes on content ● Questions on activity and projects ● Verbal questions for comprehension ● End of Unit assessment
M, A	***Teacher prepares notes and leads class discussions*** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R)	
A, T	***Analysis of Changing Atmospheric Composition Through Time:*** Students will construct a graph that shows how the composition of the atmosphere has changed over Earth's history and how life on Earth has affected Earth's systems and provide explanations for the change over time.(W, H, E2)	
M, A	***Carbon Balance Activity:*** Students calculate the amount of carbon moving among Earth's spheres with and without human activity in order to illustrate how human activities have altered the carbon balance on Earth (E1, E2, T, O)	
T, M, A	***Carbon Footprint Activity:*** Students explore their carbon consumption and create a personalized carbon footprint (W,H,E1,R,E2,T,O)	
A	**Article: Carbon Cycle (Khan Academy)** students explore in more detail about the processes, speed of transformation/length of residency, and forms of carbon, as well as impact on the planet. (W, E1, E2, O)	

<table>
<tr><th colspan="3">Unit 10: The Atmosphere and Energy - Stage 1 Desired Results</th></tr>
<tr><td rowspan="3">ESTABLISHED GOALS

HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth’s surface can create feedback that causes changes to other Earth systems.

HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate

RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…

● SEP 1- Ask Questions
● SEP 3- Plan and Carry Out Investigations
● SEP 4- Analyze and Interpret Data
● SEP 5- Use Mathematics and Computational Thinking
● SEP 7- Engage in Argument from Evidence</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS
Students will understand that…

● ESS2.D
○ The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space. (HS-ESS2-2)

● ESS2.D
○ Changes in the atmosphere due to human activity have</td><td>ESSENTIAL QUESTIONS
Students will keep considering…

● What regulates Earth’s weather and climate?

● What are the impacts of greenhouse gases on our planet's temperature and how does changing the balance have negative consequences on our planet?

● Why can locations at the same latitude have drastically different weather and climate?</td></tr>
</table>

context relevant to grades 9-10 texts and topics **RST.9-10.5** Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy) **RST 9-10.7** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.	increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-4)	
	Acquisition	
	Students will know… ● There is a relationship between angle of insolation, latitude and temperature. ● How albedo can impact atmospheric temperature and create a feedback loop. ● There is a difference in specific heat of water and land which can cause unequal heating of the air. ● The series of steps it takes for energy to transform/change from the sun to the heating of the atmosphere. ● Carbon dioxide, and other greenhouse gasses, are affecting the heat balance in the atmosphere and causing a change in weather and climate. ● CCC (Energy and Matter) how energy flows and changes within Earth's system. ● CCC (Cause and Effect) how to explain the causal relationship between energy in the system and the variables that affect it.	*Students will be skilled at…* ● Explaining the relationship between angle of insolation and the amount of heat that the surface can generate and transfer to the air. ● Calculating changes in energy based on latitude and angle of insolation ● Conducting an experiment about the differences between land and water in terms of heat available for transfering to the air. ● Explaining what specific heat is and calculating the amount of energy needed to change the temperature of land and water ● Elaborating about the effects of albedo and air temperature. ● Conducting and experiment that measures the differences in temperature of objects of different albedo ● Model different atmospheric energy feedback loops, such as : albedo and increase greenhouse gases. ● Interpreting monthly insolation values for different latitudes.

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T, M, A	Rubric for: proper graphing and proper information in the Claim-Evidence-Reasoning sections.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* **Goal:** A group of scientists have been collecting data to try and determine why a penguin population has been decreasing over the past 2 decades. **Role:** each student will specialize in specific scientific study collecting data about their topic. **Audience:** The group will be a key presenter at a Climate Change Conference to present their findings to the audience. **Situation:** A group of scientists have collected a variety of data and are analyzing why the population of penguins has been on a rapid decline. They combine the different data sets to present their claim for the population crash. (with evidence and reasoning) **Product:** Poster board of all data sets, descriptions of their data, and Claim-Evidence-Reasoning section. **Standards:** Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* A,M Summative Assessments M,T Questioning of Students A,M,T Warm-ups and Exit Tickets A,M,T In-class Activities and Projects

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring
A, M	● ***Lab: Angle of Insolation (Honors Version)*** - Students will calculate how much energy each unit of area is absorbing based on different angles of light striking the surface. Then students will analyze the data to make connections between changes in angle of insolation and surface temperatures in different parts of the world and at different times of day. (W, H, E1, E2, T)	● Quizzes on content ● Questions on activity and projects ● Verbal questions for comprehension ● End of Unit assessment
A, M, T	● ***Lab: Albedo (Honors Version)*** - Students will collect and analyze temperature data of various colors (black/silver cans, or various color paper sleeves) and then analyze the data to make predictions about	

	potential feedback mechanisms that occur as surface reflectivity changes. (W, H, E1, E2, T)	
A, M	• ***Lab: Heating of land vs. water*** - students will collect temperature data of air just above the surface of a container with water and a different container with soil (land) for a set amount of time. A heating lamp will represent the sun. (W, H, E1, E2, T)	
A, M, T	• ***Greenhouse Effect: (PhET Simulation)*** - Students run a simulation demonstrating the impact of various greenhouse gases and the impact it has on temperature. (H, E1, E2, T, O)	

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<table>
<tr><th colspan="3">Unit 11:Climate Change and the Future - Stage 1 Desired Results</th></tr>
<tr><td rowspan="3">ESTABLISHED GOALS

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…

● SEP 1 - Ask Questions
● SEP 2 - Develop and Use Models
● SEP 4 - Analyze and Interpret Data
● SEP 6- Construct Explanations
● SEP 8 - Obtain, Evaluate and Communicate Information</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS
Students will understand that…

● ESS2.D
○ Current models predict that, although future regional climate changes will be complex and</td><td>ESSENTIAL QUESTIONS
Students will keep considering…

● How do we know what the climate was like in the past?

● What human activities have an impact on</td></tr>
</table>

RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics **RST.9-10.7** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words **RST.9-10.8** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem	varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere ● **ESS3.D** ○ Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict and manage current and future impacts ● **ESS3.D** ○ Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities	Earth's climate and what can be done to minimize those impacts? ● What information is included in climate models and how can they be used to help make predictions about the future?
	Acquisition	
	Students will know…	*Students will be skilled at…*

	● The foundation for Earth's global climate system is the electromagnetic radiation from the sun as well as its reflections, absorption, storage and redistribution among the Earth's various spheres ● CCC (Patterns) Climate change can occur when certain parts of Earth's systems are altered as evidenced by the geological record ● CCC (Systems and System Models) to define parameters of systems and develop a model to explain them. ● Changes in the atmosphere due to human activity have increased greenhouse gas concentrations and have an effect on climate ● Global climate models incorporate scientists' best knowledge of physical and chemical processes and the interactions of relevant systems ● Current climate models predict that although future regional climate changes will be complex and varied, average global temperatures will continue to rise ● When the source of an environmental problem is understood, new technologies and regulations can be utilized to regulate human activities in order to mitigate global impacts	● Evaluating historical climate data to describe how Earth's climate has changed ● Identifying several climate proxies and explain how each is used to reconstruct past climates ● Describing several resources used to collect modern climate data such as satellites, ocean probes and land and ship based weather stations ● Analyzing and interpreting current climate models to show how Earth's global temperature has been increasing and will continue to increase into the future ● Asking questions about what factors should be included in a climate model and how climate models are created and used ● Explaining the importance of resolution in creating climate models and discuss the limitations of modern technology in reproducing high resolution, accurate models ● Discussing the impact of climate change on future populations ● Evaluating technological improvements, legislative acts and best management practices which may improve the conditions caused by global climate change

Stage 2 – Evidence		
Code	**Evaluative Criteria**	**Assessment Evidence**
T,M,A	Rubric to assess graphing skills, claim accuracy, appropriate use of evidence, and reasoning that connects claim to content.	PERFORMANCE TASK(S): *Students will show that they really understand evidence of…* Use a climate model to make a prediction about future impacts climate change will have on a community and then make a set of recommendations to mitigate or prevent those impacts **Goal**: Use several climate models and data sets (seal levels, wildfire frequency, storm intensity, etc.) to predict the potential future impact on a U.S. city and make recommendations for mitigation **Role**: City Planner **Audience**: City Development Committee **Situation**: You've been asked to develop a plan for a major U.S. city's response to consequences of future climate change **Product/Performance**: Presentation to the City Development Committee that includes future impacts of climate change, mitigation strategies and potential technological solutions that can be implemented. **Standards**: Rubric

		OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by…* ● Quizzes and Tests ● Formative assessments ● Lab analysis and reflection on results ● Warm-ups and exit tickets ● Article readings/summaries ● Homework assignments

Stage 3 – Learning Plan		
Code	***Pre-Assessment*** ● Brainstorming at the start of the unit ● Informal assessment of prior knowledge ● Formal pre-assessments to match the post assessment (optional)	
	Summary of Key Learning Events and Instruction *Student success at transfer meaning and acquisition depends on…*	Progress Monitoring ● Quizzes on content ● Questions on activity and projects ● Verbal questions for comprehension ● End of Unit assessment
M,A	**Teacher prepares notes and leads class discussions** - to introduce unit, provide content, provide opportunity formative assessment, and address misconceptions (W,H,R)	
T,M,A	***Analyzing Past Climates Using Climate Proxies:*** Analyze temperature graphs generated by analysis of ice core data in order to explore past climates. Look at other climate proxy data to reconstruct past climates. Explain how climate proxies work and provide detailed descriptions of several common proxies and what information is used to reconstruct climate (H,E1,O)	
T,M,A	***Climate Model Comparisons (Honors Version):*** Compare various climate models and evaluate which models are best at predicting future climates based on the quality and quantity of data included in the model. Discuss the importance of resolution and explain why there is a limit to the accuracy of climate models. (W,E1,R,E2,T,O)	
A	***Article: Modern Methods of Collecting Climate Data:*** Reading about modern methods of collecting data from satellites, ocean probes and land and ship based weather stations (W,R,T,O)	

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