ASTRONOMY CURRICULUM

Middle Township Public Schools

216 S. Main Street

Cape May Court House, NJ 08210

Born on May 14, 2020

Astronomy

Unit 1: The Cycles of the Sky

Time Frame: 15 Days

NGSS Disciplinary Core Ideas

ESS1.B: Earth and the Solar System

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

LEARNING STATEMENTS (NGSS Performance Expectations):

***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.**
[Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students describe the motion of the Sun, Moon, and stars as they rise along the eastern horizon, move across the sky, and set along the western horizon.
- Students recognize the kinds of fixed patterns of stars called constellation.
- Students explain why different constellations are visible at different times of the year.
- Students define the cycles of the Sun, Moon, and stars that are the basis for the day, month, and year.
- Students describe how and why the shape of the lit portion of the Moon seen from Earth changes during the month.
- Students relate the tilt of the Earth's axis to the changes in the apparent daily path of the Sun during the course of the year.
- Students explain why the tilt of the Earth's axis leads to seasonal changes of temperature on the Earth, and how its effects differ on different parts of the Earth.
- Students describe where, and how frequently, lunar and solar eclipses occur, and describe the visual phenomena associated with each.
- Students explain why eclipses are rare, and why their dates gradually shift.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Midterm & final exams
- Unit projects

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
ESS2-4 Moon Phases Lab: Students use Styrofoam balls to simulate the	• Reduce group size and pair with positive peer model. • Simplify directions by modeling lab activity.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing

Moon, which will be lit by a single light source in the classroom. They observe how different positions of their ball are illuminated as they hold it in various positions. They will create a complete series of phases matching the Moon's appearance. They will relate lunar phases to the position of the Earth and Sun. https://www.southampton.ac.uk/~sj2y10/moonPhasesSheetA3.pdf **ESS2-4** Seasons Simulation: Students will examine the main factors which affect temperature: the position of the Earth in its orbit around the Sun, the tilt of the Earth's axis of rotation, and the path of the Sun in the sky over the course of a day. Students will be able to make connections between these factors and the average temperature over the course of	• Address moon phase misconceptions prior to the start of the activity. • Assist students as necessary in order to achieve correct phases. • Provide template for students to record data. • Reinforce concepts via notes/videos/follow up manipulative activity. • Simplify/explain the wording of lab simulation questions. • Provide written directions that correspond to online directions. • Provide each student with an individual computer. • Assist students as necessary to avoid misconceptions. • Reinforce concepts via notes/videos/follow up manipulative activity.	correlation and make claims about specific causes and effects.	models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Use a model to provide mechanistic accounts of phenomena. ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

a year. http://highered.mheducation.com/sites/007299181x/student_view0/chapter2/seasons_interactive.html **Additional Resources** Explorations: Introduction to Astronomy (Arny), 6th Edition (Student Center) http://glencoe.mheducation.com/sites/0010202009/student_view0/index.html Astronomy Education at the University of Nebraska-Lincoln http://astro.unl.edu/			

Astronomy

Unit 2: The Rise of Astronomy

Time Frame: 20 Days

NGSS Disciplinary Core Ideas

ESS1.B: Earth and the Solar System

- 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 from, or collisions with, other objects in the solar system.

LEARNING STATEMENTS (NGSS Performance Expectations):

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

[Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.] [Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler's laws of orbital motions should not deal with more than two bodies, nor involve calculus.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students explain the different lines of simple observational evidence that prove the Earth is round.
- Students show how the relative distances and sizes of the Moon and Sun can be estimated from basic observation.
- Students explain why ancient astronomers thought the Earth was at the center of the Universe, and describe what they thought planets were and how they explained planets' motions.

- Students explain Copernicus's arguments that the Earth is a planet orbiting the Sun, and explain how his reasoning accounts for planets' retrograde motion.
- Students describe the characteristics of planetary orbits discovered by Kepler as given by his three laws.
- Students calculate the period of a planet's orbit from its semimajor axis, or calculate its semimajor axis from its period.
- Students describe Galileo's telescope observations, and discuss why these were so upsetting to ancient beliefs about the nature of the Universe.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Unit projects

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
ESS1-4 The Ellipse: In this activity, students will become familiar with the properties of an ellipse and related it to the orbits of the Moon and planets. http://stevekluge.com/geoscience/regentses/labs/esrellipsedr	• Simplify/explain the wording of lab simulation questions. • Provide written directions that correspond to online directions. • Provide each student with an individual computer. • Reduce group size and pair with positive peer model. • Assist students as	**Scale, Proportion, and Quantity** • 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). ***Connections to Engineering,***	**Using Mathematical and Computational Thinking** Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions,

aw.pdf **ESS1-4** Planets Orbit Lab: Students will understand the definition and components of an ellipse: semimajor axis, semiminor axis, focus, eccentricity. Students will identify planetary orbits as ellipses with the sun at one focus and correlate this identification with Kepler's 1st Law. Students will demonstrate understanding that orbital speeds vary with time or place in the orbit and connect this variation of speed with Kepler's 2nd law. Student will be able to give the definition of Kepler's 3rd law and the units for which it is applicable. http://astro.unl.edu/naap/pos/pos.html	necessary to avoid misconceptions. ● Reinforce concepts via notes/videos/follow up manipulative activity. ● Emphasize concept over calculations.	***Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ● Use mathematical or computational representations of phenomena to describe explanations.

Additional Resources Explorations: Introduction to Astronomy (Arny), 6th Edition (Student Center) http://glencoe.mheducation.com/sites/0010202009/student_view0/index.html Astronomy Education at the University of Nebraska-Lincoln http://astro.unl.edu/			

Astronomy

Unit 3: The Solar System

Time Frame: 20 Days

NGSS Disciplinary Core Ideas

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 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.

ESS1.B: Earth and the Solar System

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary)

ESS2.A: Earth Materials and System

- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

ESS2.D: Weather and Climate

- 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 reradiation into space.

LEARNING STATEMENTS (NGSS Performance Expectations):

***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.**

[Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]

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.
[Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students identify the primary components of the Solar System, and describe their distinctive properties.

- Students discuss the differences between terrestrial, Jovian, and dwarf planets, and their satellites, and recount why astronomers reclassified Pluto.
- Students recall the age of the Solar System and explain how it is determined.
- Students describe the steps in the formation of the Solar System according to the nebular theory and relate these to the properties of the planets and other bodies.
- Students explain why disks are expected to form around young stars, and describe the observations that indicate disks are present around young stars.
- Students describe the role of planetesimals in planet formation and modification, and where some can still be found.
- Students discuss the roles of rocky, icy, and gaseous materials in the formation of planets and their atmospheres.
- Students describe and contrast the internal structure of the three other terrestrial planets with the Earth's.
- Students describe the runaway greenhouse model and how the process is thought to have begun on Venus.
- Students discuss how the terrestrial planets' climate vary with distance from the Sun, and orbital and rotation differences.
- Students describe and contrast the basic characteristics of the four gas giant planets, and compare them in size to the Earth.
- Students explain the causes of Jupiter's banded atmosphere, and how it differs in appearance from Saturn.
- Students summarize the properties of Jupiter's Great Red Spot, and explain what drives its rotation.
- Students explain why Uranus and Neptune look blue.
- Students contrast the properties of the ring systems around the Jovian planets.
- Students describe the various classes of small bodies that orbit the Sun.
- Students describe the different kinds of meteorites and what their different compositions indicate about their origins.
- Students describe how asteroids were discovered, and retell the changing nomenclature used for some of them, from planet to asteroid to dwarf planet.
- Students describe the characteristics and structure of a comet.
- Students explain how comets' tails arise, what direction they point, and comets' connection with meteor showers.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Unit projects/presentation

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
ESS1-6 Planet Project: Students will use websites and library resources to gather information about a planet and its moons. In small groups, students will plan and create a slideshow for their assigned planet, and present their assigned planet to the class. **ESS1-6** Dimensions of the Solar System: Students will compute the orbit distances and sizes of the planets on a scale model and then draw a model of the solar system that shows relative orbit distances and	● Provide a presentation rubric to promote student success. ● Allow students to present work to teacher individually if needed. ● Emphasize content over creativity/format. ● Provide visual examples that correspond to actual presentation format. ● Reduce group size and pair with positive peer model. ● Allow for rough draft revisions if needed. ● Reinforce concepts via notes/videos/follow up manipulative activity. ● Assist students will scaling calculations for the model.	**Stability and Change** ● Much of science deals with constructing explanations of how things change and how they remain stable. **Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ● Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. **Developing and Using Models**

sizes of planets. http://hmxearthscience.com/Warehouse/astronomy/documents/Dimensions%20of%20the%20Solar%20System%20LAB.pdf **Additional Resources** Explorations: Introduction to Astronomy (Arny), 6th Edition (Student Center) http://glencoe.mheducation.com/sites/0010202009/student_view0/index.html Astronomy Education at the University of Nebraska-Lincoln http://astro.unl.edu/	• Provide additional visual aides to represent the planets. (colored beads or colored pencils) • Use graph paper to assist in scaled distances.		Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Use a model to provide mechanistic accounts of phenomena. ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new

			evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. ● Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. **Scientific Knowledge is Based on Empirical Evidence** ● Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

Astronomy

Unit 4: The Sun

Time Frame: 15 Days

NGSS Disciplinary Core Ideas

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.
- 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 nonstellar 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.
- 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.

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. (secondary)

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. (secondary)

LEARNING STATEMENTS (NGSS Performance Expectations):

***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 in the form of radiation.**

[Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.]

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.

[Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).]

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

[Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass

of a star and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.]

EVIDENCE OF LEARNING:

FORMATIVE:

- Students describe the structure of the Sun from its core to the solar wind, and indicate the approximate temperatures and densities of the various layers.
- Students explain why the Sun must continuously generate heat and what becomes of the energy it generates.
- Students describe the process of nuclear fusion and what conditions are necessary for it to take place.
- Students explain how magnetic fields and gas in the Sun interact, and describe features on the Sun that arise as a result.
- Students discuss how magnetic fields grow and remain strong in sunspots, and how they cause sunspots to be dark.
- Students explain how magnetic fields can make the corona so hot.
- Students describe the solar cycle, its cause, and how it was varied in the past.
- Students describe how solar activity affects the Earth through both individual events and long-term changes in the Sun.

SUMMATIVE:

- Laboratory Activities
- Interactive Simulations
- Unit Assessments
- Benchmark Assessment
- Unit projects

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices

ESS1-1 Sunspot Lab: As an introduction, students identify sunspots on images of the Sun, discover- ing that the number, location, and size of spots is not always the same. During the first part of the activity, students make a graph that shows how the number of sunspots has changed over the past 30 years. Interpreting their graphs, students discover that there is a regular pattern to the number of sunspots (the 11-year sunspot cycle). During the second part of the activity, students interpret a graph of sunspot data from the coldest part of the Little Ice Age (Maunder Minimum).	• Simplify wording lab questions • Rephrase/explain directions orally that correspond to written directions. • Simplify the amount of data required to graph and/or provide a partially completed graph. • Allow students to use online graphing programs if needed. • Group with positive peer models	**Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. **Energy and Matter** • Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology**	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and

ESS1-1 Solar Rotation Lab: In this activity students use 12 images from the SOHO space telescope to track sunspots in order to measure the rate of solar rotation. **Additional Resources** Explorations: Introduction to Astronomy (Arny), 6th Edition (Student Center) http://glencoe.mheducation.com/sites/0010202009/student_view0/index.html Astronomy Education at the University of Nebraska-Lincoln http://astro.unl.edu/		• Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. • Science assumes the universe is a vast single system in which basic laws are consistent.	theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and 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. **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in

			multiple formats (including orally, graphically, textually, and mathematically). ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ● A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.

Astronomy

Unit 5: Properties and Evolution of Stars

Time Frame: 20 Days

NGSS Disciplinary Core Ideas

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.
- 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 nonstellar 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.
- 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.

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. (secondary)

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. (secondary)

LEARNING STATEMENTS (NGSS Performance Expectations):

***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 in the form of radiation.**

[Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.]

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.

[Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches

that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).]

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

[Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.]

SUGGESTED ACTIVITY FOR… (PE's indicated with * above)	SPECIAL EDUCATION MODIFICATIONS	EXTENSION OPPORTUNITIES Cross Cutting Concepts	Alignment to Science and Engineering Practices
ESS1-1 Family of Stars In this activity, students sort and order cards to illustrate the lifecycles of a red dwarf, a Sun-like star, and a blue giant. Students will collaborate with other groups to see if they found the same results; any discrepancies will be discussed. Students move on to calculate the	● Simplify wording lab questions ● Rephrase/explain directions orally that correspond to written directions. ● Simplify the amount of calculations required. ● Provide calculators ● Group with positive peer models ● Extended time as needed	**Scale, Proportion, and Quantity** ● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. **Energy and Matter** ● Energy cannot be created	**Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

time stars spend during some of their life stages. **ESS1-3** H-R Diagram In this activity students use the tables in their textbooks to plot a local H-R diagram. They will gain a solid understanding of the H-R diagram by doing so. **Additional Resources** Explorations: Introduction to Astronomy (Arny), 6th Edition (Student Center) http://glencoe.mheducation.com/sites/0010202009/student_view0/index.html Astronomy Education at the University of Nebraska-Lincoln http://astro.unl.edu/	• Utilize colored pencils to aid visualization	or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	• Develop a model based on evidence to illustrate the relationships between systems or between components of a system. **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and 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

		Connections to Nature of Science **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. ● Science assumes the universe is a vast single system in which basic laws are consistent.	future. **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. ● Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ● A scientific theory is a

			substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.