Westside High School
Astronomy Curriculum Map
2018-2019

Teacher: C. Campbell **Revised: June 2018**

Map is still under construction and will be revised throughout the year.

WESTSIDE HIGH SCHOOL ASTRONOMY CURRICULUM MAP

Teacher: C. Campbell

Topic 1: ~ 4 Weeks

Topic: Observational Astronomy

Students recognize and classify objects in the sky based on the prior knowledge gained using observational evidence. Students use star maps to find objects in the sky and extrapolate their predicted locations based on various coordinate systems.

Essential Questions:

Students will consider……

- How do objects in the sky form patterns of motion?
- How do humans use maps to find their way on the celestial sphere and classify objects seen in the sky according to location, color, magnitude, and other astronomical measures?

Students will…..

- --Under Construction--

AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

Students who demonstrate understanding can: A-ESS1-1AR Develop a model using observational evidence that accounts for patterns in the diurnal, seasonal, and annual movements of objects on the celestial sphere. [Clarification Statement: Students record observations of the night sky or use observational data from computer models (Stellarium.org).] A-ESS1-2AR Obtain, evaluate, and communicate information gathered from observational evidence, maps, and charts to demonstrate an understanding of the ecliptic patterns, magnitudes, and colors of stars, and the dynamic locations of constellations, asterisms, and planets. [Clarification Statement: Students use both major coordinate systems (Right Ascension/Declination, Altitude/Azimuth). Students account for the independent dynamic motions of the planets, Moon, and sun in contrast with the fixed nature of constellations. A1-ETS1-2 Design a solution to a complex real world problem by

breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: A possible real world problem would be to design a way to reduce local light pollution to facilitate the observation of the night sky.]			
Science/Engineering Practices	**Disciplinary Core Idea**	**Crosscutting Concepts:**	
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. (A1-ETS1-2) 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. (A-ESS1-1AR) Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (A-ESS1-1AR) Communicate technical information or 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	ESS1.A: The Universe and Its Stars The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (A-ESS1-1AR, A-ESS1-2AR) 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. (A-ESS1-1AR, A-ESS1-2AR) PS4.C: Information Technologies and Instrumentation Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, and scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (A-ESS1-2AR) ETS1.A: Defining and Delimiting Engineering Problems Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (A1-ETS1-2) Humanity faces major global challenges	Patterns Empirical evidence is needed to identify patterns. (A-ESS1-1AR) Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (A-ESS1-1AR) Scale, Proportion, and Quantity The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (A-ESS1-1AR) -------------------------------------- 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. (A1-ETS1-2) Influence of Engineering, Technology, and Science on Society and the Natural World New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (A1-ETS1-2)	

orally, graphically, textually, and mathematically). (A-ESS1-1AR) -- 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. (A-ESS1-1AR) Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. (A-ESS1-1AR)	today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (A1-ETS1-2) ETS1.B: Developing Possible Solutions 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. (A1-ETS1-2) Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (A1-ETS1-2) ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (A1-ETS1-2)		
Activities/Skills	**Assessments**	**Resources**	**Vocabulary**
• --Under Construction--	• --Under Construction--	• --Under Construction--	• --Under Construction--

Topic 2: ~ 4 Weeks

Topic: Early History of Astronomy

Students research astronomical models developed by early civilizations. Students use early models of astronomy to accurately and effectively explain the nature of celestial objects and their patterns of motion. Students develop heliocentric models from geocentric models.

Essential Questions:

Students will consider…

- How did diverse early societies around the world use astronomy to improve their daily lives?
- How did astronomy develop from a primitive superstition into a modern, mathematically-based science?

Students will…..

- --Under Construction--

AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS

A-ESS2-1AR Engage in arguments from evidence about how the development of astronomy in the pre-telescopic age laid the groundwork for modern astronomy. [Clarification Statement: Emphasis is on development and cultural importance of time keeping, navigation, and measurement of the Earth-Moon system.]
A-ESS2-2AR Construct explanations of how the telescope impacted the evolution of solar system models from geocentric to heliocentric. [Clarification Statement: Emphasis is on the development of the geocentric model by Aristotle and Ptolemy to the development of the Copernican astronomical model which was facilitated by Galileo's telescopic astronomy.]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data	PS4.C: Information Technologies and Instrumentation Multiple technologies based on the understanding of waves and their interactions with matter are part of	Patterns Empirical evidence is needed to identify patterns. (A-ESS2-1AR) Different patterns may be observed at each of the scales at which a system is	

sets for consistency, and the use of models to generate and analyze data. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (A-ESS2-1AR) Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Construct an oral and written argument or counter-arguments based on data and evidence. (A-ESS2-1AR) 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. Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (A-ESS2-2AR) -- Connections to Nature of Science Scientific Knowledge is Based on Empirical Evidence Science knowledge is based on empirical evidence. (A-ESS2-1AR, A-ESS2-2AR) Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (A-ESS2-1AR, A-ESS2-2AR) Science includes the process of coordinating patterns of evidence with current theory. (A-ESS2-1AR, A-ESS2-2AR)	everyday experiences in the modern world (e.g., medical imaging, communications, and scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (A-ESS2-1AR, A-ESS2-2AR) ETS1.B: Developing Possible Solutions Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (A-ESS2-1AR, A-ESS2-2AR)	studied and can provide evidence for causality in explanations of phenomena. (A-ESS2-1AR) Scale, Proportion, and Quantity The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (A-ESS2-2AR) Systems and System Models When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (A-ESS2-2AR) Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (A-ESS2-2AR)	
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**

• --Under Construction--	• --Under Construction--	• --Under Construction--	--Under Construction--

Topic 3: ~ 4 Weeks

Topic: Gravitation

Students develop models to show the effects and motions of rotationally dynamic systems. Students use Newton's laws of gravitation, Pascal's law of pressure, and the principles of thermodynamics to explain planetary structures across a wide class of objects from small moons to Jovian giants and stars.

Essential Questions:

Students will consider…

- What motivates and controls the various linear and rotational motions of objects in the cosmos?
- How can mathematical models show linear and orbital accelerated motion?
- How does gravity affect the evolution and structure of discrete objects from the smallest asteroid to the largest galactic clusters?

Students will…..

- --Under Construction--

AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

A-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. [AR Clarification Statement: Emphasis is on applying Kepler's laws of elliptical planetary motion to determine how gravitation affects planetary orbits and orbital velocity.]
A-ESS3-1AR Use mathematics and computational thinking to demonstrate rotationally dynamic systems and how these structures scale from solar systems to galaxies to bound galactic clusters.[Clarification Statement: Emphasis is on the use of mathematical models of rotationally dynamic systems to apply Newton's laws of gravitation and Kepler's laws of planetary motion.]
A-ESS3-2AR Construct an explanation of how gravitational forces are influenced by mass, density, and radius and how these forces impact the evolution of planetary structure, surfaces, atmospheres, and rings. [Clarification Statement: Emphasis is on how gravitational forces cause changes in planetary structure, including differentiation of the interior and mediation of ring and moon formation.]
A3-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. [AR Clarification Statement: Real-world problems could include launching a satellite into geosynchronous orbit or safely landing an orbital vehicle on the surface of a planet or moon. Criteria and constraints could include the mass of the vessel, gravitational conditions on different planets and moons, fuel, materials used, starting position, and velocity vectors.] The performance expectations ab

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
Using Mathematics 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, 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. Create a computational model or simulation of a phenomenon, designed device, process, or system. (A-ESS1-4 A-ESS3-1AR) Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (A-ESS1-4, A-ESS3-1AR) Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (A-ESS1-4, A-ESS3-1AR) 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 knowledge, principles, and theories. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that	PS2.A: Forces and Motion Newton's second law accurately predicts changes in the motion of macroscopic objects. (A-ESS1-4, A-ESS3-2AR) Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (A-ESS1-4) If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (A-ESS1-4) PS2.B: Types of Interactions Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (A-ESS3-2AR) Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (A-ESS3-2AR) PS3.C: Relationship Between Energy and Forces When two objects interacting through a field change relative position, the energy stored in the field is changed. (A-ESS3-1AR) 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. (A-ESS3-1AR) ETS1.A: Defining and Delimiting Engineering Problems Criteria and constraints also include	Cause and Effect Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (A-ESS3-2AR) Patterns Empirical evidence is needed to identify patterns. (A-ESS1-4) Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (A-ESS1-4) Scale, Proportion, and Quantity The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (A-ESS3-1AR) Stability and Change Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (A3-ETS1-4) Feedback (negative or positive) can stabilize or destabilize a system. (A3-ETS1-4) ------------------------------------ Connections to Engineering, Technology, and Applications of Science Influence of Engineering, Technology, and Science on Society and the Natural World Modern civilization depends on major technological systems. (A3-ETS1-4) Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (A3-ETS1-4) New technologies can have deep impacts on society and	

describe the natural world operate today as they did in the past and will continue to do so in the future. (A-ESS3-2AR) Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (A-ESS3-2AR) Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (A-ESS3-2AR) Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (A-ESS3-2AR) 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. (A3-ETS1-4)	satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (A3-ETS1-4) Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (A3-ETS1-4) ETS1.B: Developing Possible Solutions 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. (A3-ETS1-4) Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (A3-ETS1-4) ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (A3-ETS1-4)	the environment, including some that were not anticipated. (A3-ETS1-4) Analysis of costs and benefits is a critical aspect of decisions about technology. (A3-ETS1-4) ---------------------------------- Connections to Nature of Science Science is a Human Endeavor Science is a result of human endeavors, imagination, and creativity. (A3-ETS1-4) Science Addresses Questions About the Natural and Material World Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (A3-ETS1-4) Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (A3-ETS1-4) Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (A3-ETS1-4)	
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**
• --Under Construction--	• --Under Construction--	• --Under Construction--	• --Under Construction--

Topic 4: ~ 4 Weeks

Topic: Formation of the Solar System

Students use astronomical units, light years, and parsecs. Students use the gravitational model of planetary assembly and evolution to explain the major classes of planets and their internal structures.

Essential Questions:

Students will consider……

- What is the origin of massive objects in the solar system and what is the role of gravity?
- How do astronomers measure objects and distances in space differently than on Earth?

Students will…..

- --Under Construction--

AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

A-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. [AR Clarification Statement: Emphasis is on evidence found on other planetary, lunar, and meteoric surfaces. Evidence could include detection of water, composition of materials, geological activity, and the evolution of planetary surfaces.]
A-ESS4-1AR Analyze and interpret data to describe how nebular theory and gravitational collapse result in star and solar system formation with distinct regions characterized by different types of planetary and other bodies. [Clarification Statement: Emphasis is on the origin and development of Laplace's nebular theory. Emphasis is also on regions of the solar system including the inner and outer solar system and the habitable.]
A-ESS4-2AR Obtain, evaluate, and communicate information about patterns of size and scale of the solar system, our galaxy, and the universe. [Clarification Statement: Emphasis is on the differences in solar, galactic, and universal distance and size scales using both qualitative and quantitative tools including scientific notation, appropriate astronomical units, light years, and parsecs.]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more	ESS1.A: The Universe and Its Stars The study of stars' light spectra and brightness is used to identify	Cause and Effect Empirical evidence is required to differentiate between cause and correlation and	

detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using computational models in order to make valid and reliable scientific claims. (A-ESS4-1AR) 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. Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (A-ESS1-6) Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (A-ESS4-2AR) Communicate technical information or 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). (A-ESS4-2AR) --- 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-ESS4-1AR, A-ESS4-2AR) Scientific	compositional elements of stars, their movements, and their distances from Earth. (A-ESS4-2AR) 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. (A-ESS1-6) PS3.B: Conservation of Energy and Energy Transfer Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (A-ESS4-1AR) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (A-ESS4-1AR) Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (A-ESS4-1AR)	make claims about specific causes and effects. (A-ESS1-6, A-ESS4-1AR) Patterns Empirical evidence is needed to identify patterns. (A-ESS4-2AR) Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (A-ESS4-2AR) Scale, Proportion, and Quantity The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (A-ESS4-2AR)	

Investigations Use a Variety of Methods Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (A-ESS4-1AR, A-ESS4-2AR) New technologies advance scientific knowledge. (A-ESS4-1AR, A-ESS4-2AR) Scientific Knowledge is Based on Empirical Evidence Science knowledge is based on empirical evidence. (A-ESS4-1AR, A-ESS4-2AR) Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (A-ESS4-1AR, A-ESS4-2AR)			
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**
● --Under Construction--	● --Under Construction--	● --Under Construction--	--Under Construction--

Topic 5: ~ 4 Weeks

Topic: The Earth, Moon, and Sun System

Students predict lunar phases based on observational evidence or orbital data. Students explain why lunar and solar eclipses occur at different frequencies and how the interaction of the Earth-Moon-sun system produces these effects. Students predict varying conditions on other planets and moons based on the Earth's seasonal and tidal cycles.

Essential Questions:

Students will consider……

- What causes eclipses and lunar phases?
- Why do planets have tides and seasons?
- Why do stars shine for millions of years?

Students will…..

- --Under Construction--

AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

A5-ESS1-1 Develop a model based on evidence to illustrate the lifespan of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. [AR Clarification Statement: This PE is partially addressed in this topic. Emphasis is on magnetic processes in the sun and their effects on the solar surface and space weather.]
A-ESS5-1AR Ask questions about relationships among the Earth, Moon, and sun to clarify the patterns of orbital positions that produce lunar phases and eclipses. [Clarification Statement: Emphasis is on the positional nature of the lunar phases, including solar and lunar eclipses, and how orbital angles between Earth, Moon, and sun create these effects.]
A-ESS5-2AR Plan and carry out investigations to demonstrate how relative orbital positions of the Earth, Moon, and sun influence energy and matter flow into and out of a system to create tides and seasons, orbital angles between Earth, Moon, and sun create these effects. [Clarification Statement: Emphasis is on identifying positional relationships that produce tides on Earth (e.g., spring and neap tides, lunar perigee and apogee). Emphasis is also on positional relationships that produce seasons on Earth and other planets (e.g., axial tilt, perihelion, aphelion).]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
Asking Questions and Defining Problems Asking questions and defining problems in 9–12 builds on K–8 experiences and	ESS1.B: Earth and the Solar System Cyclical changes in the shape of Earth's orbit around the sun, together with	Energy and Matter The total amount of energy and matter in closed systems is conserved. (A5-ESS1-1,	

progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (A-ESS5-1AR) 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). Use a model to provide mechanistic accounts of phenomena. (A-ESS5-1AR) Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (A-ESS5-2AR) --- 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-ESS5-1AR, A-ESS5-2AR) Scientific Investigations Use a Variety of Methods Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (A-ESS5-1AR, A-ESS5-2AR) New technologies advance scientific	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. (A-ESS5-1AR, A-ESS5-2AR) ESS2.A: Earth Materials and Systems 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. (A-ESS5-1AR, A-ESS5-2AR) 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 re-radiation into space. (A5-ESS1-1) PS3.A: Definitions of Energy Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (A5-ESS1-1, A-ESS5-2AR)	A-ESS5-2AR) Energy drives the cycling of matter within and between systems. (A5-ESS1-1, A-ESS5-2AR) Structure and Function The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (A5-ESS1-1) Patterns Empirical evidence is needed to identify patterns. (A-ESS5-1AR)Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (A5-ESS1-1)	

knowledge. (A-ESS5-1AR, A-ESS5-2AR) Scientific Knowledge is Based on Empirical Evidence Science knowledge is based on empirical evidence. (A-ESS5-1AR, A-ESS5-2AR) Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (A-ESS5-1AR, A-ESS5-2AR)			
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**
• --Under Construction--	• --Under Construction--	• --Under Construction--	--Under Construction--

<u>Topic 6:</u> ~ 4 Weeks

Topic: Electromagnetic Magnetic Radiation and Matter

Students use the concept of full-spectrum electromagnetic radiation to explain how stars transmit both energy and information about their structure and composition. Students investigate the dual wave-particle nature of light.

Essential Questions:

Students will consider……

- What powers the Sun and how does it transmit energy and information out into space?
- How can light be both a wave and a particle?
- How does the dual nature of light impact the use and development of optical technology?

Students will…..

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AR STANDARDS / SKILLS *CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.*			
A6-ESS1-1 Develop a model based on evidence to illustrate the lifespan of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. [AR Clarification Statement: This PE is partially addressed in this topic. Emphasis is on the role of nuclear fusion in the sun's core producing radiant energy that reaches out into space and carries information about the sun's composition, temperature, and other physical processes.] A-ESS6-1AR Plan and carry out investigations to demonstrate the dual nature of light as a wave and particle that transmits energy and information about the nature and motion of the matter that emitted it. [Clarification Statement: Emphasis is on the wave and particle nature of light, including the entire range of the electromagnetic spectrum, the use of spectroscopy to investigate the composition of matter, and the use of Doppler shift to determine the relative motion of stars and galaxies.] A6-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Possible major global challenges could include disruptions to communication and navigational networks including satellites and land-based communications or use and design of night vision goggles that convert electromagnetic radiation beyond the visible range into useful information.]			
Science/Engineering Practices	**Disciplinary Core Idea**	**Crosscutting Concepts:**	
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). Use a model to provide mechanistic accounts of phenomena. (A6-ESS1-1) Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (A-ESS6-1AR) Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and	PS1.A: Structure and Properties of Matter A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (A-ESS6-1AR) PS1.B: Chemical Reactions Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (A6-ESS1-1) PS3.A: Definitions of Energy Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (A-ESS6-1AR) PS4.B Electromagnetic Radiation Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the	Energy and Matter The total amount of energy and matter in closed systems is conserved. (A-ESS6-1AR) Energy drives the cycling of matter within and between systems. (A-ESS6-1AR) Systems and System Models When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (A6-ESS1-1) Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (A6-ESS1-1) ------------------------------------- Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and	

analysis, a range of linear and nonlinear functions including trigonometric functions, 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. Create a computational model or simulation of a phenomenon, designed device, process, or system. (A6-ETS1-1) Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (A6-ETS1-1) Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (A6-ETS1-1) -- 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. (A6-ESS1-1) Scientific Investigations Use a Variety of Methods Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (A6-ESS1-1, A-ESS6-1AR) New technologies advance scientific knowledge. (A6-ESS1-1, A-ESS6-1AR) Scientific Knowledge is Based on Empirical Evidence Science knowledge is based on empirical evidence. (A6-ESS1-1, A-ESS6-1AR) Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (A6-ESS1-1, A-ESS6-1AR)	presence of an element, even in microscopic quantities. (A-ESS6-1AR) Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (A-ESS6-1AR) When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, Xrays, gamma rays) can ionize atoms and cause damage to living cells. (A-ESS6-1AR) Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (A-ESS6-1AR) ESS1.A: The Universe and Its Stars The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (A6-ESS1-1) 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. (A6-ESS1-1) ETS1.B: Developing Possible Solutions 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. (A6-ETS1-1)	benefits is a critical aspect of decisions about technology. (A6-ETS1-1)	
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**

• --Under Construction--	• --Under Construction--	• --Under Construction--	--Under Construction--

<u>Topic 7:</u> ~ 4 Weeks

Topic: Stellar Evolution

Students model the life cycle and potential long-term stability of a star given initial conditions of mass and composition. Students model the different pathways for heavy and light element synthesis, and relate these ideas to different known classes of stars.

Essential Questions:

Students will consider……

- How does a star's initial mass and composition uniquely determine its stability, lifespan, structure, and final state after cataclysmic star death?
- Where do various elements in the universe originate and what processes account for their production and abundance?

Students will…..

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AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

A7-ESS1-1 Develop a model based on evidence to illustrate the lifespan of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. [AR Clarification Statement: Emphasis is on developing a model based on evidence to illustrate the lifespan of the sun.]
A-ESS1-3 Communicate scientific ideas about the way stars, over their lifecycle, produce elements. [AR Clarification Statement: Emphasis is on the fusion process and the production of elements of atomic #2 (helium) - #26 (iron); elements more massive than iron are produced only during a supernova event at the end of a star's life.]
A-ESS7-1AR Construct an explanation of how a star's initial mass uniquely determines the conditions that affect stability and factors that control rates of change over its lifetime. [Clarification Statement: Emphasis is on how initial mass determines the life cycle of a star as described by the Russell-Vogt theorem.]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
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	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. (A7-ESS1-1,	Cause and Effect Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (A7-ESS1-1) Structure and Function The functions and	

natural and designed world(s). Use a model to provide mechanistic accounts of phenomena. (A7-ESS1-1) 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. Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (A-ESS7-1AR) Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (A-ESS1-3) Communicate technical information or 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). (A-ESS1-3) --- 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. (A7-ESS1-1, A-ESS1-3, A-ESS7-1AR) Scientific Investigations Use a Variety of Methods Science investigations use diverse methods and do not always use	A-ESS1-3, A-ESS7-1AR) ESS1.A: The Universe and Its Stars The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (A7-ESS1-1, A-ESS1-3, A-ESS7-1AR) 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. (A7-ESS1-1, A-ESS1-3, A-ESS7-1AR)	properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (A-ESS1-3, A-ESS7-1AR) Scale, Proportion, and Quantity The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (A7-ESS1-1)	

the same set of procedures to obtain data. (A7-ESS1-1, A-ESS1-3, A-ESS7-1AR) New technologies advance scientific knowledge. (A7-ESS1-1, A-ESS1-3, A-ESS7-1AR) Scientific Knowledge is Based on Empirical Evidence Science knowledge is based on empirical evidence. (A7-ESS1-1, A-ESS1-3, A-ESS7-1AR) Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (A7-ESS1-1, A-ESS1-3, A-ESS7-1AR)			
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**
--Under Construction--	--Under Construction--	--Under Construction--	--Under Construction--

Topic 8: ~ 4 Weeks

Topic: Cosmology

Students develop arguments based upon Hubble's data of galactic motion to account for universal expansion. Students construct a model of galactic rotation data demonstrating the existence and effects of dark matter halos around galaxies.

Essential Questions:

Students will consider……

- What evidence do astronomers use to explain the origins of the universe?
- How are galaxies formed?
- How does evidence support both expansion of the universe and the existence of dark matter and dark energy?

Students will…..

- --Under Construction--

AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

A-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. [AR Clarification Statement: Emphasis is on dark energy, accelerating cosmic expansion, Hubble's law, and the discovery of the expansion of the universe. Examples of evidence could include cosmic abundances of light elements, the red shift found in galactic spectra, and cosmic microwave background radiation.]
A-ESS8-1AR Construct an argument from evidence that the formation of galactic structures depends on a spherical dark matter halo that surrounds a galaxy and supermassive black holes at the center of the galaxy. [Clarification Standard: Emphasis is placed on galactic structures which influence the evolution of the galaxy and influence the rates of star formation in higher density regions of the galaxy.]
A8-ETS1-3 Evaluate a solution to a complex real world problem based upon prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: Use qualitative and quantitative data to analyze a major global challenge for space systems which could include human space travel, terraforming, and colonizing other planets.]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and	PS4.B Electromagnetic Radiation Atoms of each element emit and absorb characteristic frequencies of light. These	Energy and Matter The total amount of energy and matter in closed systems is conserved. (A-ESS1-2)	

progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (A-ESS8-1AR) 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. Evaluate a solution to a complex real-world problem, based on scientific knowledge, studentgenerated sources of evidence, prioritized criteria, and tradeoff considerations. (A-ESS1-2) --- 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-ESS8-1AR) Scientific Investigations Use a Variety of Methods Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (A-ESS8-1AR) New technologies advance scientific knowledge. (A-ESS8-1AR) Scientific Knowledge is Based on Empirical Evidence Science knowledge is based on empirical evidence. (A-ESS8-1AR) Science arguments are strengthened by	characteristics allow identification of the presence of an element, even in microscopic quantities. (A-ESS1-2) ESS1.A: The Universe and Its Stars The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (A-ESS1-2) The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (A-ESS1-2) 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. (A-ESS1-2)ETS1.B: Developing Possible Solutions 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. (A8-ETS1-3)	Energy drives the cycling of matter within and between systems. (A-ESS1-2) Structure and Function The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (A-ESS8-1AR) -- Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (A8-ETS1-3)	

multiple lines of evidence supporting a single explanation. (A-ESS8-1AR)			
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**
--Under Construction--	--Under Construction--	--Under Construction--	--Under Construction--