Wethersfield Public Schools

WHS Curriculum: Astronomy

Grade(s)	11 & 12
Unit Title and Purpose	**Unit 1: In the Beginning (The Big Bang)**
Timeframe	4-5 weeks

Vision of the Graduate

Problem Solver: Students work to explain the origins of the universe from the beginning to today, using supporting evidence to build understanding.
Collaborator: Students collaborate to model large scale phenomena, drawing on prior knowledge, common understanding, making sense of something new.
Communicator: Students diagram/model, present in small and large groups settings, and communicate in written form what they understand focusing on evidence and supporting details.

Unit Priority Standards

Next Generation Science Standards
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.

Disciplinary Core Ideas
HS-ESS1.A. The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gasses, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
HS-ESS1-A. 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.

Science & Engineering Practices
Constructing Explanations and Designing Solutions. 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.
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.

Unit Supporting Standards

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
HS -PS4.B. Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.

Essential Questions

How did the universe form?

How does light help us understand the universe?

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How has the universe evolved to what we know today?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
S1. Construct an explanation of the Big Bang Theory S2. Use changes in light spectra to support the theory that the universe is expanding S3. Compare and contrast the composition of matter within the universe	K1. Big Bang Theory K2. Hubble's Law K3. Properties of Light Waves K4. Emission of Light from Distant Objects
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**
Investigation: Students participate individually and in small groups to investigate, identify, and discuss the major pillars supporting the Big Bang Theory **Model:** The Big Bang Theory - Using a phenomena video of the Big Bang, student create an initial model of what they believe to be the details of the Theory *Resources:* Scientists of the Big Bang Theory; Evolution/Timeline of our Understanding **Model:** Waves - Students differentiate between transverse & longitudinal waves, measuring wavelength, frequency, amplitude, & energy *Resources:* Observation of the Universe; Transverse Wave Properties; Wavelength, Frequency, Speed & Energy; Electromagnetic Spectrum in our Lives **Investigation:** Waves and Light Spectra - Students measure continuous, absorption, and emission spectra *Resource:* Spectroscope - Analysis of Light **Model:** The Doppler Effect - Students model the redshift versus blueshift according to the Doppler Effect, then calculate the distance between Earth and other galaxies based on the changes in light spectra of galaxies in our Universe *Resources:* Redshift, Distance & Speed; Expanding Universe Model	● Chapter 22 - Origin of Modern Astronomy - Pearson ● Balloons ● Extra-Long Slinkies ● Rope ● Meter Sticks ● Spectroscopes ● Stop Watches ● Periodic Tables ● Spectroscopes ● Color Pencils ● Permanent Markers ● Rulers ● Glue

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WHS Curriculum: Astronomy

Grade(s)	11 & 12
Unit Title and Purpose	**Unit 2: Our Star**
Timeframe	4-5 weeks

Vision of the Graduate

Problem Solver: Students work to explain the formation of our stars, how they are different, and how we know our star, the sun, is one of the newer stars in the universe using supporting evidence to build understanding.
Collaborator: Students collaborate to model large scale phenomena, drawing on prior knowledge, common understanding, making sense of something new.
Communicator: Students diagram/model, present in small and large groups settings, and communicate in written form what they understand focusing on evidence and supporting details.

Unit Priority Standards

Next Generation Science Standards
HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation
HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.

Disciplinary Core Ideas
HS-ESS1-A. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
HS-PS4.B. Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.

Science & Engineering Practices
Developing & Using Models. Develop a model based on evidence to illustrate the relationships between systems or between components of a system.
Obtaining, Evaluating, & Communicating Information. 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).

Unit Supporting Standards

HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission and fusion.
H-PS4.B. Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.

Essential Questions

What is the fate of our sun? Do all stars evolve in the same way?

How do we know what a star is made of?

How does the structure of the sun impact the release of energy and material from the surface?

Why is the sun a "newer" star in our universe?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
S1. Develop models to illustrate the life span of the sun	K1. Life Cycle of the Sun

S2. Collect scientific evidence S3. Develop a model of the layers of star and the impact on the planets around them S4. Communicate scientific ideas about how stars evolution producing elements	K2. Nuclear Fusion K3. Function of the Layers of a Star and their Impact K4. Production of Elements/Nucleosynthesis
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**
Inferencing: Students are given an H-R diagram and compare different class stars with minimal background knowledge, allowing students to create questions about the "Why?" behind the different classifications. *Resource:* H-R Diagram & Properties of Stars **Simulation:** Star in a Box - Students identify and describe the stages of stellar evolution, determining the defining factor that makes one star different from another *Resources*: Star in a Box Simulation, Questions **Simulation:** Nucleosynthesis: The Creation of Elements - Students are given objects that represent protons, neutrons, atoms, and molecules. Students then model nucleosynthesis using these objects, going through transformations from protons up to gold. *Resource:* Nucleosynthesis **Investigation:** Spectral Fingerprint - Students differentiate between stages of stellar evolution based on known spectral fingerprints. *Resource:* Spectral Fingerprint Practice **Discussion, Video, Reading, & Drawing:** Composition and Structure of the Sun - Students identify what they think they know about the sun, watch a clip of solar phenomena, and use a scientific reading to create a drawing of the sun and the role of each component *Resources:* The Sun: Fusion at Work Article; Questions **Investigation & Graphing:** Sunspots - Students evaluate how solar activity can impact Earth *Resources:* Properties of Stars and the H-R Diagram; Sunspot Activity - Sunspot Data & Graph, Questions **Project:** Stars Beyond Our Own - Students select a star, describing the properties, life cycle, and location of the star they choose. Students then compare their star with the sun and explain why they are different. *Resource:* Star Project	● Chapter 24 - Studying the Sun - Pearson ● NASA - Star Basics ● Telescopes: ○ Stargazing at Night ○ Sunspot Observations (with proper filters) ● Proton, Neutron, & Atom Objects - Suggestions: beads, legos, labeled magnets, laminated labeled circles ● Color Pencils ● Permanent Markers ● Rulers ● Glue

Grade(s)	11 & 12
Unit Title and Purpose	**Unit 3: Touring Our Solar System**
Timeframe	4-5 weeks

Vision of the Graduate

Problem Solver: Students work to explain the formation of our planets, how they are different, and how they move using supporting evidence to build understanding.
Collaborator: Students collaborate to model large scale phenomena, drawing on prior knowledge, common understanding, making sense of something new.
Communicator: Students diagram/model, present in small and large groups settings, and communicate in written form what they understand focusing on evidence and supporting details.

Unit Priority Standards

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

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

Science & Engineering Practices
Use Mathematical and Computational Thinking. Use mathematical or computational representations of phenomena to describe explanations.
Constructing Explanations and Designing Solutions. Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
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.

Unit Supporting Standards

HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects.
HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems.

HS-ESS1-C. 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.

Essential Questions

Is the motion observed in our solar system predictable?

How are the objects in the solar system different from each other?

How come life is sustainable on Earth, but no other planet?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
S1. Calculate the gravitational forces within the solar system S2. Predict the motion of the orbiting objects within the solar system S3. Construct a theory for the formation of the solar system S4. Create a model of how Earth evolved S5. Compare the objects as our solar system as evidence of the stages of the solar system formation	K1. Newton's Law of Gravitation K2. Kepler's Laws of Planetary Motion K3. Formation of our Solar System K4. Evolution of the geosphere, biosphere, hydrosphere & atmosphere from a geological, biological, and physical perspective K5. Properties of the objects in our Solar System
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**
Presentation: Historical Astronomy - Students present about one of the scientists that help develop our current understanding about our solar system. *Resource:* Historical Astronomy **Model:** The Solar System - Students go in the hallway, or outside, to identify the position of the planets in comparison to the sun. **Diagram:** The Solar System - Create a usable diagram to identify distances and locations of each object in our solar system. *Resources:* Solar System Diagram & Pictures **Investigation:** Composition of Planets - Focusing on the similarities, students investigate what makes the composition of inner planets so different from the outer planets. Resources: NASA Solar System Exploration, What is in the Solar System?, Solar System Search **Model:** Earth's Evolution - Students investigate changes over time and create a model of how Earth evolved.	● Chapter 23 - Touring Our Solar System - Pearson ● NASA - Solar System Exploration ● History of Earth - In Brief ● NOVA - Life's Rocky Start ● NASA - Meteors, Meteoroids, & Meteorites ● NASA - Comets ● NASA - Asteroids ● Space - Comets ● Space - Asteroids ● Natural History Museum - Meteor, Meteorites, Meteoroids, Asteroids, & Comets ● Resource - Asteroids, Comets, Meteors, Meteorites, & Meteoroids ● Color Pencils ● Permanent Markers ● Rulers ● Glue

Diagram & Small Group Discussion: Asteroids, Comets, Meteoroids, Meteors, & Meteorites - Students research each vocabulary word, diagram their structures with relative sizes, discuss observations in small groups and then collaboratively complete the comparison chart. *Resources*: Asteroids, Comets, Meteoroids, Meteors, & Meteorites; The Sky is Falling **Simulation:** Newton's Laws of Gravitation *Resource:* PhET Simulation - Gravity Force **Simulation**: Kepler's Laws of Planetary Motion *Resource:* PhET Simulation - Kepler's Laws of Planetary Motion	

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Grade(s)	11 & 12
Unit Title and Purpose	**Unit 4: Observational Astronomy**
Timeframe	4-5 Weeks

Vision of the Graduate

Problem Solver: Students work to explain how we observe the universe, learn from those observations, and make inferences on Earth and other parts of the universe using supporting evidence to build understanding.
Collaborator: Students collaborate to model large scale phenomena, drawing on prior knowledge, common understanding, making sense of something new.
Communicator: Students diagram/model, present in small and large groups settings, and communicate in written form what they understand focusing on evidence and supporting details.

Unit Priority Standards

Science & Engineering Practices
Developing & Using Models. Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Unit Supporting Standards

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Essential Questions

Is the moon important to Earth's systems?

How come we are looking back in time when we are looking at the night sky?

Is there extraterrestrial life somewhere in the universe? Intelligent or otherwise?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
S1. Discuss how the sun, Earth, and moon system makes the Earth a dynamic system. S2. Identify the different objects seen in the night sky and differentiate between them. S3. Compare the Milky Way to other galaxies.	K1. Sun, Earth, & Moon dynamics K2. Constellations, galaxies & other solar systems K3. Types of Galaxies

Student Learning Tasks & Resources	Suggested Teacher Materials & Resources
Model: Moon, Earth, & Sun Connections - Students model the motion of the moon, Earth, and the sun, focusing on tides, lunar eclipses, solar eclipses, etc. **Investigation:** Earth's Tides - Students investigate how Earth's tides change throughout the day and month, utilizing a tide chart, moon phase map, and webcams.	● Chapter 22 - Origin of Modern Astronomy - Pearson ● NASA - Earth's Moon - Tide Cycle ● EarthSpace Lab - Solar & Lunar Eclipses ● eduMedia - Lunar Eclipse ● eduMedia - Eclipses ● Go Astronomy - Constellations of the Night Sky ● Sky & Telescope - Sky Chart & Simulation

Simulation: Solar & Lunar Eclipse - Students participate in a solar and lunar eclipse simulation, drawing what they observe. Students then discuss in small groups their observations and describe why their observations make sense using a stick-ball model provided. Students diagram each stage and label it. **Investigation & Presentation:** Seashore Flooding during King Tides - Students pick a location in New England that has seen significant flooding during the winter months, such as Mystic, CT or Hampton, NH, and analyze the cause, human and natural. Students create a town plan for next steps to avoid loss of life and reduce economic impact. **Investigation & Model:** Star Systems (Constellations) - Students map a constellation of their choosing, identifying the stars, galaxies, or star systems that make up each constellation. Students then model how far each object is to understand the vastness of space between objects. Students also include the location over time as seen by Earth, as Earth rotates & revolves. **Diagram:** Galaxies Beyond Our Own - Students investigate the different types of galaxies in our universe and diagram the shapes, compositions, focusing on what we know and what we still don't understand. **Investigation:** Parallax - How Far? - Students learn how we know how far objects are from Earth using the concept of parallax.	● Astronomy - Learn the Constellations ● Stellarium - Online Star Map ● The Sky Live - Planetarium ● NASA - Galaxies

Grade(s)	11 & 12
Unit Title and Purpose	**Embedded Topics: Historical Astronomy: Past & Future**
Timeframe	Throughout the semester

Vision of the Graduate

Problem Solver: Students work to understand the historical perspective and how we think we know the origin of the universe, using supporting evidence to build understanding.
Collaborator: Students collaborate to model large scale phenomena, drawing on prior knowledge, common understanding, making sense of something new.
Communicator: Students diagram/model, present in small and large groups settings, and communicate in written form what they understand focusing on evidence and supporting details.

Unit Priority Standards

Next Generation Science Standards
HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios
HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science & Engineering Practices
Engaging in Argument from Evidence. 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).
Asking Questions and Defining Problems. Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
Constructing Explanations and Designing Solutions. Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.

Unit Supporting Standards

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

Essential Questions

Should we continue to spend money on space travel?

What are the challenges of space exploration? Is it worth putting people's lives at risk?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
S1. Create a timeline of space travel & astronomical understanding	K1. The scientists: What did they discover? What was their evidence? What equipment did they use? K2. Impact of space travel on our understanding of Earth

S2. Identify ways that space travel has impacted our lives, or could in the future. S3. Justify the expenditure of both money and human lives against the benefit of space travel	and the universe. K3. Future space travel; travel to the moon, Mars, & asteroids.
Student Learning Tasks & Resources	**Suggested Teacher Materials & Resources**
Internet Investigation: Students participate individually and in small groups to identify and discuss the major pillars supporting the Big Bang Theory *Resource:* The Big Bang - Class Investigation **Presentations:** Historical Astronomy - Students present about one of the scientists that help develop our current understanding about our solar system. *Resource*: Historical Astronomy **Debate:** Traveling to Other Planets - Students debate one of four positions: (1) Yes, absolutely (2) Yes, but Mars is too far (3) No, unmanned missions make more sense (4) No, we shouldn't be spending money and energy leaving Earth's surface	● National Geographic - Origins of the Universe 101 ● What is the Evidence for the Big Bang? ● What did the Stars Give Us ● The Beginning of Everything ● How Big is the Universe? ● What is Farthest Away ● Space.com - Famous Astronomers ● Chapter 22 - Origin of Modern Astronomy - Pearson