Hazelwood School District

High Expectations For All!

Astronomy

Grades 10-12

Curriculum Committee Members

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Reviewed by High School Teachers on February 6, 2018

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Hazelwood School District

Mission Statement

We are a collaborative learning community guided by a relentless focus to ensure each student achieves maximum growth

Vision Statement

HSD will foster lifelong learners, productive citizens, and responsible leaders for an ever-evolving society.

Board of Education on January 5, 2010

Goals

Goal #1: Hazelwood students will meet or exceed state standards in all curricular area with emphasis in reading, writing, mathematics, science and social studies.

Goal #2: Hazelwood staff will acquire and apply skills necessary for improving student achievement.

Goal #3: Hazelwood School District, the community, and all families will support the learning of all children.

Curriculum Overview

Astronomers seek to understand how the universe – the planets, stars and galaxies – have evolved and functioned over time. This knowledge helps to shape our understanding of the physical world. Some of the questions answered are, how old is the earth and what is a black hole?

Astronomy is an elective course which provides a broad survey of the field of Astronomy in one semester of study. The course is designed to have a minimum of mathematical investigation and to be accessible to a diverse population. Cultural history and relevance is emphasized in the sections on observational astronomy and astronomy and society. The project-based course is easily differentiated for students with a variety of educational needs. Astronomical investigations are highlighted from ancient peoples to the most modern methods, which are explored with the internet and other resources.

This one semester course provides the opportunity to develop knowledge and understanding about the solar system, galaxy, and universe in which we live. Much attention is given to an appreciation for how we have obtained this information about the universe. Students use tools of observation to learn about space and learn how other astronomers, past and present, have used tools available. Areas of study include: the process of science, including use of the tools used to observe the sky; stellar astronomy and how stars change over time; and planetary astronomy and how interstellar spacecraft are obtaining information about other bodies in the solar system.

The curriculum contains assessments modeled after the Performance Tasks from the new Missouri Learning Standards for Earth and Space Science. The content of this course focuses specifically on Space Science, barring the Earth science components. The learning activities are suggested, but **the assessments are required**.

COURSE TITLE: Astronomy
GRADE LEVEL: 10-12

CONTENT AREA: High School Science

Course Description:
This course teaches students to understand the basic principles of astronomy, including the motion of objects, relative distances, and the fundamental processes that govern the formation of celestial objects. Students will investigate the characteristics of the universe, solar system, galaxies, stars, and planets. In addition, they will develop an understanding of the basic principles that govern the motion of celestial objects. Laboratory investigations are included in each unit.
Course Rationale:
The purpose of this course is to enable students to develop and apply knowledge of the universe and compare the conditions, properties, and motions of bodies in space. Emphasis shall be placed on concepts basic to Earth, including materials, processes, history, and the environment. This course introduces students to the composition and structure of the universe. Astronomy is the scientific study of the contents of the entire universe. This course will provide students with a study of the universe and the conditions, properties, and motions of bodies in space. The content includes, but is not limited to, historical astronomy, astronomical instruments, the celestial sphere, the solar system, the earth as a system in space, the earth/moon system, the sun as a star, and stars.

Course Scope and Sequence		
First Semester		
Unit 1: The Sky	**Unit 2: The solar system then and now**	**Unit 3: Stars**
11 – 90 minute class periods	14 – 90 minute class periods	14 – 90 minute class periods
• Cycles of the moon – moon path, phases, eclipses, and tides	• The origin of modern astronomy – historical perspectives, philosophical and physical laws	• Starlight and atoms – composition of stars, stellar spectroscopy

• Cycles of the Sun – apparent sun path, seasons	• Big Bang Theory (not the TV show) – the age and origin of the universe	• The Sun – structure and function of our own Sun.
• The Scale of the Cosmos – relative distances, basic units of measure	• Solar system formation – how the planets and solar system were formed	• The family of stars – measuring mass, brightness, distance of stars, HR diagrams
• The sky and celestial sphere – observational terms and coordinates, constellations	• Solar system objects – the eight planets, Pluto, moons, asteroids, etc.	• The formation of stars – how stars are born
		• Stellar evolution – the life-cycle of stars, the death of stars, how size determines its end. Neutron stars and black holes.

Approved Course Materials and Resources

Chaissson, E., and McMillan, S. (2018). *Astronomy Today*. 9th Edition. New York, New York: Pearson.

Essential Terminology/Vocabulary

Unit 1:

Annular eclipse, apogee, asterisms, astronomical unit (AU), autumnal equinox, celestial sphere, circumpolar, constellations, ecliptic, epicycle, evening star, light year (ly), lunar eclipse, lunar phase, morning star, neap tides, parallax, penumbra, perigee, precession, retrograde motion, revolution, rotation, scientific notation, sidereal period, small-angle formula, solar eclipse, spring tides, summer solstice, synodic period, totality, umbra, vernal equinox, winter solstice, and zenith.

Unit 2:
Acceleration of gravity, Big Bang Theory, blackbody radiation, cosmic microwave background, cosmology, eccentricity, ellipse, escape velocity, equivalence principle, general relativity, geocentric, gravitational field, heliocentric, inertia, inverse square law, Kepler's laws, momentum, semi-major axis, space-time, special relativity, spectrum, and theory.

Unit 3:
Apparent brightness, astronomical unit (AU), binary stars, black hole, blackbody radiation, chromosphere, corona, dynamo effect, Doppler effect, dwarf (star), escape velocity, excited atom, fusion, giant (star), ground state, HR Diagram, intrinsic brightness (or absolute brightness), luminosity, main-sequence stars, nebula, neutron star, nova, parallax, parsec (pc), photosphere, protostars, pulsars, quantum physics, redshift, singularity, spectra, spectroscopy, Stefan-Boltzmann law, supergiant (star), supernova, and Wien's law.

Unit Objectives:

Unit 1:

1. I can distinguish between solar and lunar eclipses and explain the Earth-Sun-Moon relationship for each.
2. I can explain the phases of the moon as they relate to the Earth-Sun-Moon system.
3. I can explain the seasons and how the Earth's tilt and angle of sunlight cause seasons.
4. I can discuss astronomical distances using various units such as light-year, parsecs, astronomical units and kilometers and understand which is most appropriate for a given measurement.
5. I can convert very large or small numbers from standard form to scientific notation and vice versa.
6. I can understand the historical significance of constellations and the celestial sphere.
7. I can describe positions of astronomical objects in the sky and methods for quantifying these relative positions.

Unit 2:

1. I can state Kepler's laws of planetary motion.
2. I can discuss the various historical models of the universe (Ptolemy, Copernicus, Kepler, Newton and Einstein).
3. I can develop and use a model of Kepler's law to predict the motion of objects in the solar system
4. I can calculate the eccentricities of each planet using the formula e = c/a.
5. I can explain how the universe was created using the Big Bang theory.
6. I can understand how the existence of Cosmic Background Microwave Radiation supports the Big Bang theory.
7. I can identify possible sources of dark matter and how it may affect the fate of the universe.

8. I can define the Hubble Constant and how it relates to the age of the universe.

Unit 3:

9. I can describe stellar spectroscopy and explain how we know what elements are in a star.
10. I can provide a summary of the formation of stars, as well as their death, and how this is affected by the type of star.
11. I can explain the life cycle of a star.
12. I can describe the nuclear processes that occur in all stars.
13. I can interpret an HR diagram and make predictions about where stars should be placed based on trends and star characteristics
14. I can assign groups to classes stars based on their properties.
15. I can distinguish between apparent vs actual brightness of stars.

Unit Description

This unit focuses on what we see in the sky - the cycles of the moon and sun, and the constellations we see at night. The unit also teaches the necessary units and methods of measurement to study these heavenly bodies.

PRIOR KNOWLEDGE NEEDED:	**SUGGESTED UNIT TIMELINE:**
• Understanding of kinematics	CLASS PERIOD (min.): Approx. 11 - 90 min periods.

Essential Questions

- How does the motion of the Earth, Sun and Moon affect what we see in the sky?
- Why does our view of the stars change throughout the year?

ESSENTIAL MEASURABLE LEARNING OBJECTIVES

Learning Objectives	**Student Friendly Learning Targets**	**CROSSWALK TO STANDARDS**			
		MLS	**PS**	**Bloom's**	**DOK**
1. Develop and use a model of the Earth-sun-moon system to explain the cyclic patterns of lunar phases and eclipses of the sun and moon	• I can distinguish between solar and lunar eclipses and explain the Earth-Sun-Moon relationship for each. • I can explain the phases of the moon as they relate to the Earth-Sun-Moon system.	6-8.ESS1.A.1		Application 3	2

2. Develop and use a model of the Earth-sun system to explain the cyclical patterns of seasons, which includes the Earth's tilt and directional angle of sunlight on different areas of Earth across the year.	• I can explain the seasons and how the Earth's tilt and angle of sunlight cause seasons.	6-8.ESS1.A.2	1.2 1.6 1.8	Understand 2	2
3. Understand the scale of the cosmos, and be able to use the appropriate measurement units when looking at astronomical bodies.	• I can discuss astronomical distances using various units such as light-year, parsecs, astronomical units and kilometers and understand which is most appropriate for a given measurement. • I can convert very large or small numbers from standard form to scientific notation and vice versa.	6-8.ESS1.B.1 9-12.ESS1.A.2	1.2 1.6 1.8	Application 3	2
4. Understand the historical naming of constellations, and how to describe their position and apparent movement on the celestial sphere.	• I can understand the historical significance of constellations and the celestial sphere. • I can describe positions of astronomical objects in the sky and methods for quantifying these relative positions.	9-12.ESS1.A.2	1.1 1.2	Application 3	2

ASSESSMENT DESCRIPTIONS*:

Suggested Formative Assessments:

1.1 quiz, 1.2 quiz, 1.3 quiz, on-line interactives

District Summative Assessment:

Unit 1 Test

Obj. #	**INSTRUCTIONAL STRATEGIES (research-based): (Teacher Methods)**
1-4	Identifying Similarities and Differences
1-4	Summarizing and Note Taking
1-4	Reinforcing Effort and Providing Recognition
1-4	Homework and Practice
1-4	Cooperative Learning
1-4	Nonlinguistic Representations
1-4	Setting Objectives and Providing Feedback
1-4	Cues, Questions and Advance Organizers
Obj. #	**ACTIVITY GUIDES ALIGNED TO OBJECTIVES**
1	The Moon
2	The Sun/Seasons
3	The Scale of the Cosmos
4	The sky and celestial sphere

UNIT RESOURCES: (include internet addresses for linking)
• https://openstax.og/details/books/astronomy • http://astro.unl.edu/interactives/ • https://www.astrosociety.org/education/k12-educators/project-astro/ • https://stardate.org/teachers • https://www.nasa.gov/pdf/622130main_SSML1Tchr.pdf • https://2016sci09.wikispaces.com/file/view/2_space_mathematics_worksheet.pdf

Essential Terminology (Key Terms)
Annular eclipse, apogee, asterisms, astronomical unit (AU), autumnal equinox, celestial sphere, circumpolar, constellations, ecliptic, epicycle, evening star, light year (ly), lunar eclipse, lunar phase, morning star, neap tides, parallax, penumbra, perigee, precession, retrograde motion, revolution, rotation, scientific notation, sidereal period, small-angle formula, solar eclipse, spring tides, summer solstice, synodic period, totality, umbra, vernal equinox, winter solstice, zenith

Assessment Literacy Strategies	
☒ Provide students with a clear and understandable vision of the learning target (Strategy #1) ☒ Use examples and models of strong and weak work (Strategy #2) ☒ Offer regular descriptive feedback (Strategy #3)	☒ Design lessons to focus on one learning target or aspect of quality at a time (Strategy #5) ☒ Teach students focused revision (Strategy #6)

☐ Teach students to self-assess and set goals (Strategy #4)	☒ Engage students in self-reflection and let them keep track of and share their learning (Strategy #7)

21st Century Skills	
Learning & Innovation Skills	**Information, Media, & Technology Skills**
☐ Creativity & Innovation	☒ Information Literacy
☒ Critical Thinking & Problem Solving	☐ Media Literacy
☒ Communication	☒ Technology Skills
☒ Collaboration	

HSD Activity Guide

Course: Astronomy

Unit: 1.1

Activity Title: The Moon

Unit Objectives Being Addressed
1. Develop and use a model of the Earth-sun-moon system to explain the cyclic patterns of lunar phases and eclipses of the sun and moon.

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• Patterns of the apparent motion of the Sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. • This model of the solar system can explain eclipses of the sun and the moon. Earth's axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth throughout the year.	• Distinguish between solar and lunar eclipses and explain the Earth-Sun-Moon relationship for each. • Explain the phases of the moon as they relate to the Earth-Sun-Moon system.

Learning Targets (I can…)
• I can distinguish between solar and lunar eclipses and explain the Earth-Sun-Moon relationship for each. • I can explain the phases of the moon as they relate to the Earth-Sun-Moon system.

Essential Questions (Student Friendly)
• What are the motions of Earth, Sun, and Moon? • What phenomena do the motions of Earth, Sun, and Moon explain? • Why do we study the night sky?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces	

Learning Activities

How will the standard be addressed?
M6 - Picturing an astronomer – intended to dispel the myth that only white men are astronomers. **Why should we care about exploding stars** – how has astronomy influence outside the scientific arena and increase familiarity with astronomical terms. **Exploring Lunar Phases with a daytime moon** – quick activity to demonstrate moon phases (either intro or review) **Phases of the Moon** – Stellarium activity for Phases of the Moon (a related reading: Phases of the Moon and the Month) **On-line ranking and sorting** - Phases of the Moon (astro.unl.edu/interactives/) **Worksheets 1-3 Phases of the Moon** (placing phases in order), 4-5 (enrichment). **Shadow activity** (a related reading on Eclipses & Libration) **PPT on Tidal Forces –** (a related reading: Tides)

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the learning target ☐ Activity allows for use of examples of strong and weak work ☒ Activity allows for regular descriptive feedback ☐ Provides an opportunity for students to self-assess and set goals	☐ Activity focuses on one learning target at a time ☐ Activity allows students to engage in focused revision ☒ Activity allows students to engage in self-reflection

Assessment

Formative Assessments	Summative Assessments
On-line interactives Quiz	Unit 1 Test (after 1.4)

Essential Terminology (Key Terms)
Annular eclipse, aphelion, apogee, crescent moon, diurnal, full moon, gibbous moon, lunar eclipse, lunar phase, neap tides, new moon, penumbra, perigee, perihelion, precession, quarter moon, revolution, rotation, sidereal period, solar eclipse, spring tides, synodic period, totality, umbra, zenith

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy astro.unl.edu/interactives/	

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills

☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication ☒ Collaboration	☒ Information Literacy ☐ Media Literacy ☒ Technology Skills

HSD Activity Guide

Course: Astronomy

Unit: 1.2

Activity Title: The Sun/Seasons

Unit Objectives Being Addressed
1. Develop and use a model of the Earth-sun system to explain the cyclical patterns of seasons, which includes the Earth's tilt and directional angle of sunlight on different areas of Earth across the year.

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• Patterns of the apparent motion of the Sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. • This model of the solar system can explain eclipses of the sun and the moon. Earth's axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth throughout the year.	• Explain the seasons and how the Earth's tilt and angle of sunlight cause seasons.

Learning Targets (I can…)
• I can explain the seasons and how the Earth's tilt and angle of sunlight cause seasons.

Essential Questions (Student Friendly)
• What are the motions of Earth, Sun, and Moon? • What phenomena do the motions of Earth, Sun, and Moon explain? • Why do we study the night sky?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces	

Learning Activities

How will the standard be addressed?
Plotting the apparent daily motion of the Sun – students plot the path of the Sun across a transparent dome. **Tutorial on Earth/Sun relations and seasons** – Information and questions about how the relationship between the Earth and Sun progressing through the seasons. **Sunrise at Stonehenge -** Students plot where the Sun rises over Stonehenge for each month of the year 2000. They will measure azimuth, and analyze the azimuth plot to see when the Sun rises, and when the sunrise azimuth changes most. **Equatorial Sundial** – Students will construct a sundial that can be adjusted due to latitude. **The Seasons –** reading and two activities (one with Stellarium) on the seasons. **PPT on Seasons** **On-line ranking and sorting –** seasons & Sun paths (http://astro.unl.edu/interactives/) **Worksheet 1-5 Seasons** – Worksheets that focus on the distance and tilt of the Earth relative to the Sun.

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒ Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the learning target ☐ Activity allows for use of examples of strong and weak work ☒ Activity allows for regular descriptive feedback ☐ Provides an opportunity for students to self-assess and set goals	☒ Activity focuses on one learning target at a time ☐ Activity allows students to engage in focused revision ☒ Activity allows students to engage in self-reflection

Assessment

Formative Assessments	Summative Assessments
On-line interactives Quiz	Unit 1 Test (after 1.4)

Essential Terminology (Key Terms)
Annular eclipse, apogee, autumnal equinox, ecliptic, lunar eclipse, morning star, parallax, perigee, precession, revolution, rotation, sidereal period, solar eclipse, summer solstice, synodic period, vernal equinox, winter solstice, zenith

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy http://astro.unl.edu/interactives/	

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills
☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication ☒ Collaboration	☒ Information Literacy ☐ Media Literacy ☒ Technology Skills

HSD Activity Guide

Course: Astronomy

Unit: 1.3

Activity Title: The Scale of the Cosmos

Unit Objectives Being Addressed
1. Understand the scale of the cosmos, and be able to use the appropriate measurement units when looking at astronomical bodies.

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• Patterns of the apparent motion of the Sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. • This model of the solar system can explain eclipses of the sun and the moon. Earth's axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth throughout the year.	• Discuss astronomical distances using various units such as light-year, parsecs, astronomical units and kilometers and understand which is most appropriate for a given measurement. • Convert very large or small numbers from standard form to scientific notation and vice versa.

Learning Targets (I can…)
• I can discuss astronomical distances using various units such as light-year, parsecs, astronomical units and kilometers and understand which is most appropriate for a given measurement. • I can convert very large or small numbers from standard form to scientific notation and vice versa.

Essential Questions (Student Friendly)
• What are the motions of Earth, Sun, and Moon? • What phenomena do the motions of Earth, Sun, and Moon explain? • How are distances in space measured? • Why do we study the night sky?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces	

Learning Activities

How will the standard be addressed?
PPT on Measurements in Space **Space mathematics worksheet 1** – Worksheet over dimensional analysis converting AU, km, ly as well as kg and m_E **snc_1d_units in space worksheet** – Worksheet over dimensional analysis converting AU, km, r_E & ly as well as mass and luminosity conversions **Solar system** – activity/worksheet on AU and years of planets **Solar system math** – worksheet on relative sizes and distances and dimensional analysis **Scale models of distances and sizes of planets** – students pace off relative distances of planets in solar system. Then compare relative sizes of planets. **The new and improved Hubble telescope** – activity to explain degrees, arcminutes and arc-seconds. **On-line ranking/sorting** – scale and angular diameter (astro.unl.edu/interactives)

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒ Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the learning target ☐ Activity allows for use of examples of strong and weak work ☒ Activity allows for regular descriptive feedback ☐ Provides an opportunity for students to self-assess and set goals	☒ Activity focuses on one learning target at a time ☐ Activity allows students to engage in focused revision ☒ Activity allows students to engage in self-reflection

Assessment

Formative Assessments	Summative Assessments
On-line interactives Quiz	Unit 1 Test (after 1.4)

Essential Terminology (Key Terms)
Degree, arcminute, arc-second, astronomical unit (AU), light year (ly), scientific notation, small-angle formula

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy http://astro.unl.edu/interactives	

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills
☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication ☒ Collaboration	☒ Information Literacy ☐ Media Literacy ☒ Technology Skills

HSD Activity Guide

Course: Astronomy

Unit: 1.4

Activity Title: The Sky and the Celestial Sphere

Unit Objectives Being Addressed
1. Understand the historical naming of constellations, and how to describe their position and apparent movement on the celestial sphere.

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• Patterns of the apparent motion of the Sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. • This model of the solar system can explain eclipses of the sun and the moon. Earth's axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth throughout the year.	• Understand the historical significance of constellations and the celestial sphere. • Describe positions of astronomical objects in the sky and methods for quantifying these relative positions.

Learning Targets (I can…)
• I can understand the historical significance of constellations and the celestial sphere. • I can describe positions of astronomical objects in the sky and methods for quantifying these relative positions.

Essential Questions (Student Friendly)
• What are the motions of Earth, Sun, and Moon? • What phenomena do the motions of Earth, Sun, and Moon explain? • How are distances in space measured? • Why do we study the night sky?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces	

Learning Activities

How will the standard be addressed?
PPT on Celestial Sphere – power point and readings on the year, ecliptic & calendar
Motion of the Sun and the Celestial Sphere – 4 part activity using Stellarium.
Understanding the Celestial Sphere - Activity to understand the Celestial sphere. Need a model sphere (http://shop.sciencefirst.com/starlab/kits/5802-celestial-sphere-single.html)
On-line ranking and sorting – motion of the sky, ecliptic and celestial sphere (astro.unl.edu/interactives/)
Worksheet 1-5 SkyMotion – worksheets on the movement of objects across the sky.
3D Constellations – making a model of a constellation to show how the appearance changes depending upon the viewer's position.

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒ Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the learning target	☒ Activity focuses on one learning target at a time
☐ Activity allows for use of examples of strong and weak work	☐ Activity allows students to engage in focused revision
☒ Activity allows for regular descriptive	☒ Activity allows students to engage in

feedback ☐ Provides an opportunity for students to self-assess and set goals	self-reflection

Assessment

Formative Assessments	Summative Assessments
On-line interactives	Unit 1 Test (after 1.4)

Essential Terminology (Key Terms)
Apogee, asterisms, autumnal equinox, celestial sphere, circumpolar, constellations, ecliptic, epicycle, perigee, precession, retrograde motion, revolution, rotation, summer solstice, synodic period, vernal equinox, winter solstice, zenith

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy http://astro.unl.edu/interactives/	

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills
☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication ☒ Collaboration	☒ Information Literacy ☐ Media Literacy ☒ Technology Skills

Unit Description

This unit focuses on our historical development as well as the present understanding of the solar system and the Universe as a whole.

PRIOR KNOWLEDGE NEEDED:	**SUGGESTED UNIT TIMELINE:**
• Understand kinematics and dynamics (how and why things move).	CLASS PERIOD (min.): Approx. 14 - 90 min periods.

Essential Questions

- How has the Universe changed since it first was formed?
- How has our understanding of the solar system and stars developed over time?
- What mathematical relationships can we use to describe planetary motion?
- What are similarities and differences among the planets in our solar system?

ESSENTIAL MEASURABLE LEARNING OBJECTIVES

Learning Objectives	**Student Friendly Learning Targets**	**CROSSWALK TO STANDARDS**			
		MLS	**PS**	**Bloom's**	**DOK**
1. Use Kepler's Laws to predict the motion of orbiting objects in the solar system.	• I can state Kepler's laws of planetary motion. • I can discuss the various historical models of the universe (Ptolemy, Copernicus, Kepler, Newton and Einstein).	9-12.ESS1.B.1	1.1 1.2 1.3	Application 3	3

			1.4		
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.	• I can explain how the universe was created using the Big Bang theory. • I can understand how the existence of Cosmic Background Microwave Radiation supports the Big Bang theory. • I can identify possible sources of dark matter and how it may affect the fate of the universe. • I can define the Hubble Constant and how it relates to the age of the universe.	9-12.ESS1.A.2	1.1 1.2	Analysis 4	3
3. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's origin.	• I can use the geological evidence to construct an account of Earth's origin and the origin of the Universe.	9-12.ESS1.C.2	1.2	Analysis 4	2

ASSESSMENT DESCRIPTIONS*:	
Suggested Formative Assessments: Quiz 2.1, quiz 2.2, on-line interactives **District Summative Assessment:** Unit 2 Test	
Obj. #	**INSTRUCTIONAL STRATEGIES (research-based): (Teacher Methods)**

1-3	Identifying Similarities and Differences
1-3	Summarizing and Note Taking
1-3	Reinforcing Effort and Providing Recognition
1-3	Homework and Practice
1-3	Cooperative Learning
1-3	Nonlinguistic Representations
1-3	Setting Objectives and Providing Feedback
1-3	Cues, Questions and Advance Organizers
Obj. #	**ACTIVITY GUIDES ALIGNED TO OBJECTIVES**
1	The origin of modern astronomy
2	Big Bang Theory
3	The planets

UNIT RESOURCES: (include internet addresses for linking)

- https://openstax.org/details/books/astronomy
- http://astro.unl.edu/interactives/
- https://www.astrosociety.org/education/k12-educators/project-astro/
- https://stardate.org/teachers
- https://mars.nasa.gov/mars-makers/

Essential Terminology (Key Terms)
Acceleration of gravity, Big Bang Theory, blackbody radiation, cosmic microwave background, cosmology, eccentricity, ellipse, escape velocity, equivalence principle, general relativity, geocentric, gravitational field, heliocentric, inertia, inverse square law, Kepler's laws, momentum, semi-major axis, space-time, special relativity, spectrum, theory

Assessment Literacy Strategies	
☒ Provide students with a clear and understandable vision of the learning target (Strategy #1)	☒ Design lessons to focus on one learning target or aspect of quality at a time (Strategy #5)
☒ Use examples and models of strong and weak work (Strategy #2)	☒ Teach students focused revision (Strategy #6)
☒ Offer regular descriptive feedback (Strategy #3)	☒ Engage students in self-reflection and let them keep track of and share their learning (Strategy #7)
☐ Teach students to self-assess and set goals (Strategy #4)	

21st Century Skills	
Learning & Innovation Skills	**Information, Media, & Technology Skills**
☐ Creativity & Innovation	☒ Information Literacy
☒ Critical Thinking & Problem Solving	☐ Media Literacy
☒ Communication	☒ Technology Skills
☐ Collaboration	

HSD Activity Guide

Course: Astronomy

Unit: 2.1

Activity Title: The origin of modern astronomy

Unit Objectives Being Addressed
1. Use Kepler's Laws to predict the motion of orbiting objects in the solar system.

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• 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.	• State Kepler's laws of planetary motion. • Discuss the various historical models of the universe (Ptolemy, Copernicus, Kepler, Newton and Einstein).

Learning Targets (I can…)
• I can state Kepler's laws of planetary motion. • I can discuss the various historical models of the universe (Ptolemy, Copernicus, Kepler, Newton and Einstein).

Essential Questions (Student Friendly)
• How has our understanding of the solar system and stars developed over time? • What mathematical relationships can we use to describe planetary motion?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces	

Learning Activities

How will the standard be addressed?
Astrology – a series of activities to differentiate between astronomy and astrology. **Moons of Jupiter –** activity to track the motion of Galileo's moons. Can be actual measurements, or completed from data given.

Sampling in Astronomy – activity to teach sampling of everyday objects & then stars.

Readings on Copernicus, Galileo, Kepler and Newton -

Estimation of Earth's Perihelion – enrichment for strong math students

PPT on Kepler's laws

Kepler's 2nd Law activity – to develop an understanding of the 2nd law.

Kepler's 3rd Law activity – to develop an understanding of the 3rd law.

On-line ranking and sorting – Kepler's laws (astro.unl.edu/interactives/)

Worksheets 1-5 Kepler – worksheets to practice applying Kepler's laws.

PPT on Newton's law of universal gravitation

On-line ranking and sorting – law of universal gravitation (astro.unl.edu/interactives/)

Worksheets 1-7 Gravity – worksheets to practice applying the law of universal gravitation.

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒ Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the	☐ Activity focuses on one learning target

learning target ☐ Activity allows for use of examples of strong and weak work ☒ Activity allows for regular descriptive feedback ☐ Provides an opportunity for students to self-assess and set goals	at a time ☐ Activity allows students to engage in focused revision ☒ Activity allows students to engage in self-reflection

Assessment

Formative Assessments	Summative Assessments
On-line interactives Quiz	Unit 2 Test (after 2.3)

Essential Terminology (Key Terms)
Acceleration of gravity, eccentricity, ellipse, escape velocity, equivalence principle, general relativity, geocentric, gravitational field, heliocentric, inertia, inverse square law, Kepler's laws, momentum, semi-major axis, space-time, special relativity

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy astro.unl.edu/interactives/	

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills
☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication	☒ Information Literacy ☐ Media Literacy ☒ Technology Skills

☒ Collaboration	

HSD Activity Guide

Course: Astronomy

Unit: 2.2

Activity Title: The Big Bang Theory (not the TV show)

Unit Objectives Being Addressed
1. 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.

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• 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.	• Explain how the universe was created using the Big Bang theory. • Understand how the existence of Cosmic Background Microwave Radiation supports the Big Bang theory. • Identify possible sources of dark matter and how it may affect the fate of the universe. • Define the Hubble Constant and how it relates to the age of the universe.

Learning Targets (I can…)
• I can explain how the universe was created using the Big Bang theory. • I can understand how the existence of Cosmic Background Microwave Radiation supports the Big Bang theory. • I can identify possible sources of dark matter and how it may affect the fate of the universe. • I can define the Hubble Constant and how it relates to the age of the universe.

Essential Questions (Student Friendly)
• How has the Universe changed since it first was formed? • How has our understanding of the solar system and stars developed over time? • What mathematical relationships can we use to describe planetary motion?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces	

Learning Activities

How will the standard be addressed?
H2_Cosmic_Calendar – Students create a calendar style time line for the universe. **Remember the Egg (or Potato)** – Students make drawings to see if they can identify an egg (or potato). Intended to teach them to look for subtle differences. **Cosmic collisions** – an activity to model impact cratering. **H5_Galaxy_Sorting** – Students will sort galaxies from photos of 20 galaxies. **On-line ranking and sorting** – Doppler effect (astro.unl.edu/interactives/) **Worksheets 1-4 Doppler** – worksheets to understand the consequences of the Doppler effect.

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒ Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the learning target	☐ Activity focuses on one learning target at a time
☐ Activity allows for use of examples of strong and weak work	☐ Activity allows students to engage in focused revision

☒ Activity allows for regular descriptive feedback ☐ Provides an opportunity for students to self-assess and set goals	☒ Activity allows students to engage in self-reflection

Assessment

Formative Assessments	Summative Assessments
On-line interactives Quiz	Unit 2 Test (after 2.3)

Essential Terminology (Key Terms)
Big Bang Theory, blackbody radiation, cosmic microwave background, cosmology, spectrum, theory

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy astro.unl.edu/interactives/	

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills
☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication ☒ Collaboration	☒ Information Literacy ☐ Media Literacy ☒ Technology Skills

HSD Activity Guide

Course: Astronomy

Unit: 2.3

Activity Title: The Planets

Unit Objectives Being Addressed
1. 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. **2. 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.**

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• 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. • 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.	• Explain how the universe was created using the Big Bang theory. • Use the geological evidence to construct an account of Earth's origin and the origin of the Universe.

Learning Targets (I can…)
• I can explain how the universe was created using the Big Bang theory. • I can use the geological evidence to construct an account of Earth's origin and the origin of the Universe.

Essential Questions (Student Friendly)
• How has the Universe changed since it first was formed? • How has our understanding of the solar system and stars developed over time?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces	

Learning Activities

How will the standard be addressed?
Overview of the solar system PPT – general overview **Solar system PPT** – a more detailed look at the solar system **Mercury Transit Orbit –** Simple look at Mercury's transits of Earth **Virtual Venus –** Using a remote telescope (or pictures from one) to verify the heliocentric view of the solar system like Galileo. **Phases of Venus activity** – alternative activity to virtual Venus. **Marsbound Lesson High School –** students plan a mission to Mars. **Questions Mars HS Lesson** – Students generate a research question for Mars. **Maker Mars Lesson** – Students will solve a problem of human habitation on Mars. **Outer planet lesson** – students will compare and contrast inner & outer planets. **Celestial Body tri-fold** – Students will choose a planet, dwarf planet or other celestial body to produce a tri-fold style brochure.

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒ Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the learning target ☐ Activity allows for use of examples of strong and weak work ☒ Activity allows for regular descriptive feedback ☐ Provides an opportunity for students to self-assess and set goals	☐ Activity focuses on one learning target at a time ☐ Activity allows students to engage in focused revision ☒ Activity allows students to engage in self-reflection

Assessment

Formative Assessments	Summative Assessments
On-line interactives Quiz	Unit 2 Test (after 2.3)

Essential Terminology (Key Terms)
Big Bang Theory, blackbody radiation, cosmic microwave background, cosmology, spectrum, theory

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy astro.unl.edu/interactives/ https://www.slooh.com/	

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills
☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication ☒ Collaboration	☒ Information Literacy ☐ Media Literacy ☒ Technology Skills

Unit Description

This unit focuses on the composition, classification, life cycle and evolution of stars including the Sun.

PRIOR KNOWLEDGE NEEDED:	SUGGESTED UNIT TIMELINE:
• Chemistry, particularly the structure of an atom. • Understand convection and radiation.	CLASS PERIOD (min.): Approx. 14 - 90 min periods.

Essential Questions

- What is the life cycle of a star?
- How can we tell the composition of stars?
- How do we categorize stars?

ESSENTIAL MEASURABLE LEARNING OBJECTIVES

Learning Objectives	Student Friendly Learning Targets	CROSSWALK TO STANDARDS			
		MLS	PS	Bloom's	DOK
1. Communicate scientific ideas about the way stars, over their life cycle, produce elements.	• I understand stellar spectroscopy and how we know what elements are in a star. • I can understand the formation of stars, as well as their death, and how this is affected by the type of star.	9-12.ESS1.A.3	1.1 1.2 1.8	Application 3	3

2. 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.	• I can explain the life cycle of a star. • I understand the nuclear processes that occur in all stars.	9-12.ESS1.A.1	1.1 1.2 1.8	Application 3	3
3. Understand a system for classification of stars based on apparent brightness, size and color.	• I can read an HR diagram. • I can group stars based on their properties. • I understand apparent vs actual brightness of stars.	9-12.ESS1.A.2	1.2 1.6 1.8	Application 3	2

ASSESSMENT DESCRIPTIONS*:

Suggested Formative Assessments:
Unit 3 quiz

District Summative Assessment:
Unit 3 Test and/or Final exam

Obj. #	INSTRUCTIONAL STRATEGIES (research-based): (Teacher Methods)
1-3	Identifying Similarities and Differences
1-3	Summarizing and Note Taking
1-3	Reinforcing Effort and Providing Recognition
1-3	Homework and Practice

1-3	Cooperative Learning
1-3	Nonlinguistic Representations
1-3	Setting Objectives and Providing Feedback
1-3	Cues, Questions and Advance Organizers
Obj. #	**ACTIVITY GUIDES ALIGNED TO OBJECTIVES**
1 & 3	The Nature and Life Cycle of Stars
2 & 3	The Galaxy and Beyond

UNIT RESOURCES: (include internet addresses for linking)

- https://openstax.org/details/books/astronomy
- http://astro.unl.edu/interactives/
- https://www.astrosociety.org/education/k12-educators/project-astro/
- https://stardate.org/teachers
- https://www.exploratorium.edu/snacks/inverse-square-law
- https://btc.montana.edu/ceres/html/LifeCycle/stars1.html
- https://sites.google.com/a/uw.edu/introductory-astronomy-clearinghouse/activities/stars/star-cards

Essential Terminology (Key Terms)

Apparent brightness, astronomical unit (AU), binary stars, black hole, blackbody radiation, chromosphere, corona, dynamo effect, Doppler effect, dwarf (star), escape velocity, excited atom, fusion, giant (star), ground state, HR Diagram, intrinsic brightness (or

absolute brightness), luminosity, main-sequence stars, nebula, neutron star, nova, parallax, parsec (pc), photosphere, protostars, pulsars, quantum physics, redshift, singularity, spectra, spectroscopy, Stefan-Boltzmann law, supergiant (star), supernova, Wien's law

Assessment Literacy Strategies

☒ Provide students with a clear and understandable vision of the learning target (Strategy #1)	☒ Design lessons to focus on one learning target or aspect of quality at a time (Strategy #5)
☒ Use examples and models of strong and weak work (Strategy #2)	☒ Teach students focused revision (Strategy #6)
☒ Offer regular descriptive feedback (Strategy #3)	☒ Engage students in self-reflection and let them keep track of and share their learning (Strategy #7)
☐ Teach students to self-assess and set goals (Strategy #4)	

21st Century Skills

Learning & Innovation Skills	Information, Media, & Technology Skills
☐ Creativity & Innovation	☒ Information Literacy
☒ Critical Thinking & Problem Solving	☐ Media Literacy
☒ Communication	☒ Technology Skills
☒ Collaboration	

HSD Activity Guide

Course: Astronomy

Unit: 3.1

Activity Title: The Nature and Life Cycle of Stars

Unit Objectives Being Addressed
1. Communicate scientific ideas about the way stars, over their life cycle, produce elements. **2. 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.** **3. Understand a system for classification of stars based on apparent brightness, size and color.**

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• The star called the Sun is changing and will burn out over a lifespan of approximately 10 billion years. • Nuclear fusion processes in the center of the Sun release the energy that ultimately reaches Earth as radiation. • 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. • 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.	• Understand stellar spectroscopy and how we know what elements are in a star. • Understand the formation of stars, as well as their death, and how this is affected by the type of star. • Explain the life cycle of a star. • Understand the nuclear processes that occur in all stars. • Read an HR diagram. • Group stars based on their properties. • Understand apparent vs actual brightness of stars.

Learning Targets (I can…)

- I can understand stellar spectroscopy and how we know what elements are in a star.
- I can understand the formation of stars, as well as their death, and how this is affected by the type of star.
- I can explain the life cycle of a star.
- I can understand the nuclear processes that occur in all stars.
- I can read an HR diagram.
- I can group stars based on their properties.
- I can understand apparent vs actual brightness of stars.

Essential Questions (Student Friendly)
• How has our understanding of the solar system and stars developed over time? • What are stars composed of? • What is the life cycle of a star? Does every star have the same life cycle?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces • Atomic structure	

Learning Activities

How will the standard be addressed?
How old are the jewels? –plotting the color and brightness of stars from the Jewelbox Cluster to determine their age. **Light Pollution –** observing stars from different sites to see the effect of light pollution. Requires students to work in the evening. **Star cards** – sorting star cards by various properties, temperature, color, distance from the Sun, etc. **Starry lives, starry skies –** classifying stars by their stage of development. **Inverse square law –** performing an activity to explain the inverse square law as it pertains to brightness of stars **On-line ranking and sorting** – Luminosity (astro.unl.edu/interactives/) **Luminosity 1-5 worksheets** – understanding luminosity and how it relates to size and temperature of stars. **On-line ranking and sorting** – Magnitudes (astro.unl.edu/interactives/) **App Abso Mag 1-4 worksheets** – relating apparent and absolute magnitude and their dependence upon distance. **Wien's Displacement lab** – On-line lab to understand Wien's Law **Wien's Law and Stefan-Boltzmann Law worksheet** – practice with these two laws **Life cycle of stars –** activity that compares life cycle of humans to stars.

Stellar evolution 1-4 worksheets – stellar evolution and HR diagrams. **Stellar lookback worksheet –** how we see the stars as they were in the past.

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒ Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the learning target ☐ Activity allows for use of examples of strong and weak work ☒ Activity allows for regular descriptive feedback ☐ Provides an opportunity for students to self-assess and set goals	☐ Activity focuses on one learning target at a time ☐ Activity allows students to engage in focused revision ☒ Activity allows students to engage in self-reflection

Assessment

Formative Assessments	Summative Assessments

On-line interactives Quiz	Unit 3 Test or Final

Essential Terminology (Key Terms)
Apparent brightness, astronomical unit (AU), binary stars, black hole, blackbody radiation, chromosphere, corona, dynamo effect, Doppler effect, dwarf (star), escape velocity, excited atom, fusion, giant (star), ground state, HR Diagram, intrinsic brightness (or absolute brightness), luminosity, main-sequence stars, nebula, neutron star, nova, parallax, parsec (pc), photosphere, protostars, pulsars, quantum physics, redshift, singularity, spectra, spectroscopy, Stefan-Boltzmann law, supergiant (star), supernova, Wien's law

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy astro.unl.edu/interactives/ https://www.slooh.com/	

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills
☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication ☒ Collaboration	☒ Information Literacy ☐ Media Literacy ☒ Technology Skills

HSD Activity Guide

Course: Astronomy

Unit: 3.2

Activity Title: The Galaxy and Beyond

Unit Objectives Being Addressed
1. Communicate scientific ideas about the way stars, over their life cycle, produce elements. **2. Understand things outside of our solar system.**

Standards

Know (Disciplinary Core Ideas)	Do (Performance Expectations)
• 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. • Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.	• Understand what we know about black holes. • Understand the concept of active galaxies. • Examine the evidence for dark energy and dark matter.

Learning Targets (I can…)
• I can understand what we think we know about black holes. • I can understand the concept of active galaxies. • I can examine the evidence for dark energy and dark matter.

Essential Questions (Student Friendly)
• How has our understanding of what's beyond the solar system developed over time? • What is in the universe besides the matter we see?

Previous Knowledge Needed	Additional Concepts
• Fundamentals of motion and forces • Atomic structure	

Learning Activities

How will the standard be addressed?
NASA Accidentally Discovers Giant Black holes - https://www.youtube.com/watch?v=lfG2-FFL6fY **Black Holes** – interactive multi-media experience. http://hubblesite.org/explore_astronomy/black_holes/home.html **Reading on black holes –** includes a reading comprehension quiz http://www.softschools.com/language_arts/reading_comprehension/science/98/black_holes/ **Black holes** – A scale model of a black hole and common myths about black holes **Active galaxies** - 3 NASA activities about an active galactic nucleus AGN **Dark matter** https://www.youtube.com/watch?v=9W3RsaWuCuE **Dark energy** https://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy

Differentiation

How will all students be reached?
Flexible grouping Tiered instruction Extended time on tasks

Integration

Science and Engineering Practices	Crosscutting Concepts
☒ Asking Questions and Defining Problems ☒ Developing and Using Models ☒ Planning and Carrying out Investigations ☒ Analyzing and Interpreting Data ☒ Using Mathematics and Computational Thinking ☒ Constructing Explanations and Designing Solutions ☒ Engaging in Argument from Evidence ☒ Obtaining, Evaluating, and Communicating Information	☒ Patterns ☒ Cause and Effect ☒ Scale, Proportion and Quantity ☒ Systems and Systems Models ☒ Energy and Matter ☒ Structure and Function ☒ Stability and Change

Assessment Literacy

☒ Activity offers a clear vision of the learning target ☐ Activity allows for use of examples of strong and weak work ☒ Activity allows for regular descriptive feedback ☐ Provides an opportunity for students to self-assess and set goals	☐ Activity focuses on one learning target at a time ☐ Activity allows students to engage in focused revision ☒ Activity allows students to engage in self-reflection

Assessment

Formative Assessments	Summative Assessments
On-line interactives Quiz	Unit 3 Test or Final

Essential Terminology (Key Terms)
Apparent brightness, astronomical unit (AU), binary stars, black hole, blackbody radiation, chromosphere, corona, dynamo effect, Doppler effect, dwarf (star), escape velocity, excited atom, fusion, giant (star), ground state, HR Diagram, intrinsic brightness (or absolute brightness), luminosity, main-sequence stars, nebula, neutron star, nova, parallax, parsec (pc), photosphere, protostars, pulsars, quantum physics, redshift, singularity, spectra, spectroscopy, Stefan-Boltzmann law, supergiant (star), supernova, Wien's law

Additional Resources

Instructional Materials	Other Resources
https://openstax.org/details/books/astronomy https://www.slooh.com/ http://hubblesite.org/explore_astronomy/black_holes/home.html	https://www.youtube.com/watch?v=lfG2-FFL6fY https://www.youtube.com/watch?v=9W3RsaWuCuE

Rigor and Relevance

Rigor	Relevance
☒ Knowledge/Awareness ☒ Comprehension ☒ Application ☒ Analysis ☒ Synthesis ☐ Evaluation	☐ Knowledge in one discipline ☒ Apply knowledge in one discipline ☒ Apply knowledge across disciplines ☒ Apply to real world predictable situations ☒ Apply to real world unpredictable situations

21st Century Skills

Learning & Innovation Skills	Information, Media & Technology Skills
☒ Creativity & Innovation ☒ Critical Thinking & Problem Solving ☒ Communication ☒ Collaboration	☒ Information Literacy ☒ Media Literacy ☒ Technology Skills