Motion of Stellar Object

Missouri Grade-Level Expectations (or other standards)

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

CCSS:

CCSS.ELA-LITERACY.RST.11-12.1

Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CCSS.ELA-LITERACY.RST.11-12.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CCSS.ELA-LITERACY.RST.11-12.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

CCSS.ELA-LITERACY.RST.11-12.7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CCSS.ELA-LITERACY.RST.11-12.8

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Learning Goal	Proficiency Scales
Students will be able to interpret how the	4: Student demonstrates an in-depth inference or advanced application

organization of the solar system can be used to understand the motion of the stars, sun, moon and planets in the sky.	or innovates with the learning goal. 3: Student demonstrates mastery with the learning goal as evidenced by: ● Evaluating the effects of the relative positions of the Earth, moon, and sun on observable phenomena, e.g. phases of the moon, eclipses, seasons, and diurnal cycles. ● Inferring the effects of orbit, mass, and other factors on real and imaginary objects. ● Describing how latitude and time of the year affect visibility of constellations. ● Predicting visibility of planets (major and minor) in the solar system based on relative orbital motion. ● Applying mathematically Newtonian gravity to celestial bodies to determine their masses and explain their motion (e.g. Kepler's Laws). 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing or recalling specific vocabulary, such as *Azimuth, Altitude, Celestial sphere, Zenith, Polaris, Circumpolar, Celestial equator, Horizon, Meridian, Vernal equinox, Autumnal equinox, Solstice (summer/winter), phases of the moon, eclipses, seasons, diurnal cycles, orbit, mass, waxing, waning, gibbous, crescent, rotation, revolution, tilt, and constellation.* ● Performing specific processes such as: ○ Identifying constellations and planets in the night sky using a sky sphere. ○ Listing the phases of the moon and seasons.

	○ Calculating orbital motions using Kepler and Newtonian laws. 1: Student demonstrates a limited understanding or skill with the learning goal.

Learning Targets

- Create sky sphere
- Analyze the causes of the seasons
- Observe and predict the moon phases
- Diagram elliptical and orbital patterns
- Manipulate Kepler's laws of planetary motion and Newton's gravitational laws
- Understand the celestial sphere and the system of celestial coordinates on the sky

Learning Design

Historical Perspective

Missouri Grade-Level Expectations (or other standards)

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.

CCSS:

CCSS.ELA-LITERACY.RST.11-12.1

Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CCSS.ELA-LITERACY.RST.11-12.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CCSS.ELA-LITERACY.RST.11-12.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

CCSS.ELA-LITERACY.RST.11-12.7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CCSS.ELA-LITERACY.RST.11-12.8

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Learning Goal	Proficiency Scales
Students will be able to analyze the dynamic nature of astronomy.	4: Student demonstrates an in-depth inference or advanced application or innovates with the learning goal.

	3: Student demonstrates mastery with the learning goal as evidenced by: ● Identifying how astronomy was integrated into ancient civilizations and then through modern astronomy. ● Examining similarities and differences in cultures about what physical, cultural, and spiritual purposes were addressed through astronomical observation and prediction. ● Investigating how the civilization learned about the universe. ● Comparing and contrasting how celestial observation was used by ancient cultures to measure time, plant crops, and influence the fate of kingdom. 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing or recalling specific vocabulary, such as *archaeoastronomy, geocentric, heliocentric, Brahe, Copernicus, Galileo, Hubble, Ptolemaic model.* ● Performing processes such as: ○ Listing the ancient, renaissance, and modern astronomer and their discoveries. ○ Recognizing that various civilizations used astronomy and the influence on modern astronomy. 1: Student demonstrates a limited understanding or skill with the learning goal.

Learning Targets

- Understand a historical approach when analyzing the formation of the universe

- Recognize names of great astronomers and know their contribution to science (Bruno, Copernicus, Brahe, Galileo , Kepler, and, also, Hubble, Friedman, Hoyle, Tinsley, Burbidge, etc.)
- Investigate other cultures beliefs and explanations of the universe

Learning Design

Exploration of the Universe

Missouri Grade-Level Expectations (or other standards)

No applicable NGSS standards.
CCSS:
CCSS.ELA-LITERACY.RST.11-12.1
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
CCSS.ELA-LITERACY.RST.11-12.3
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
CCSS.ELA-LITERACY.RST.11-12.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

CCSS.ELA-LITERACY.RST.11-12.7
Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCSS.ELA-LITERACY.RST.11-12.8
Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Learning Goal	Proficiency Scales
Students will be able to articulate the challenges inherent in human exploration of the universe.	4: Student demonstrates an in-depth inference or advanced application or innovates with the learning goal. 3: Student demonstrates mastery of the learning goal as evidenced by: ● Investigating space exploration through historical evidence. ● Reasoning the purpose and desire of human space exploration. 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing or recalling specific vocabulary, such as *sputnik, Apollo, Gemini, Mars Rover, Hubble, Voyager.* ● Performing specific processes, such as identifying the major space explorations and generalizing rationale for human space exploration. 1: Student demonstrates limited understanding or skill with the learning goal.

Learning Targets

- Identify different methods of the space exploration
- Describe the history of piloted space projects
- Analyze advances in astronomical instruments
- Discuss future opportunities of space exploration

Learning Design

Evolution and Evidence of Stellar Objects

Missouri Grade-Level Expectations (or other 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.
CCSS:

CCSS.ELA-LITERACY.RST.11-12.1

Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CCSS.ELA-LITERACY.RST.11-12.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CCSS.ELA-LITERACY.RST.11-12.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

CCSS.ELA-LITERACY.RST.11-12.7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CCSS.ELA-LITERACY.RST.11-12.8

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Learning Goal	Proficiency Scales
Students will be able to categorize stars and describe their life cycles.	4: Student demonstrates an in-depth inference or advanced application or innovates with the learning goal. 3: Student demonstrates mastery of the learning goal as evidenced by: ● Describing the life cycle of a star and explaining the role gravity and mass play in the brightness, life span, and end-stages of stars. ● Describing how spectroscopy provides information about the inherent properties and motions of objects. ● Relating nuclear fusion reactions and mass-energy equivalence to the life cycle of stars.

	● Explaining the relationship between the energy produced by fusion in stars to the luminosity. ● Analyzing the energy relationships between the mass, power output, and lifespan of stars. ● Describing energy transfers and transformations associated with the motion and interactions of celestial bodies (e.g. orbits, binary pulsars, meteors, black holes, and galaxy mergers). 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing or recalling specific vocabulary, such as *blue giant, dwarf, HR diagram, parsec, red giant, red dwarf, spectroscopic parallax, protostar,nebulae, spectroscopy, luminosity, orbits, binary pulsars, meteors, black holes, and galaxy mergers.* ● Performing processes such as: ○ Outlining the life cycle of a star using correct sequence and terminology. ○ Identifying spectrums of light related to various types of stars. ○ Correlating the mass of stars to the stage in life or the type of star. 1: Student demonstrates limited understanding or skill with the learning goal.

Learning Targets

- Define the concept of atomic structure
- Identify continuous, emission, and absorption spectra

- Understand Kirchoff's rules of spectral analysis
- Describe the meaning of Wein's and Stefan-Boltzmann's laws
- Define major characteristics of stars
- Discuss steps of stellar evolution
- Identify different categories of luminous astronomical objects and describe their properties

Learning Design

Composition and Observation of the Universe

Missouri Grade-Level Expectations (or other standards)

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system
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.
CCSS:
CCSS.ELA-LITERACY.RST.11-12.1
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
CCSS.ELA-LITERACY.RST.11-12.3
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
CCSS.ELA-LITERACY.RST.11-12.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific

scientific or technical context relevant to *grades 11-12 texts and topics*.
CCSS.ELA-LITERACY.RST.11-12.7
Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCSS.ELA-LITERACY.RST.11-12.8
Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Learning Goal	Proficiency Scales
Students will be able to differentiate among the objects that comprise the universe.	4: Student demonstrates an in-depth inference or advanced application or innovates with the learning goal. 3: Student demonstrates mastery with the learning goal as evidenced by: ● Critiquing and analyzing the main arguments and evidence in support of the standard cosmological model (e.g. elements, solar systems, and universe). ● Comparing and contrasting the major properties of the components of our solar system. ● Applying the science of comparative planetology to identify similarity and differences in planets and how to identify components of types of planets. ● Analyzing the development and composition and position of objects in the universe. 2: Student demonstrates he/she is nearing proficiency by: ● Recognizing or recalling specific vocabulary, such as *Jovian, terrestrial, moon, asteroid, accretion, albedo, cosmology.* ● Performing specific processes, such as ○ Outlining the arguments of the development of the universe. ○ Listing properties of the objects of the universe. ○ Identifying similarities and differences of planets in the solar system.

	1: Student demonstrates a limited understanding or skill with the learning goal.

Learning Targets

- Research various theories for the origin of the universe
- Investigate the composition and origin of various components of the universe (comets, asteroids, planets, etc)
- Compare and contrast the similarities and differences of stellar objects, such as comparing terrestrial and gaseous planets

Learning Design