Course Title – Astronomy

Implement start year – 2018-2019

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Unit # 2 , topic – The Solar System

Transfer Goal –

Students will be able to independently use their learning evaluate the value of continued space exploration.

Stage 1 – Desired Results

Established Goals

New Jersey Student Learning Standards (NJSLS)-Science
http://www.state.nj.us/education/cccs/2016/science/
New Jersey Student Learning Standards (NJSLS)-English/Language Arts
http://www.state.nj.us/education/cccs/2016/ela/

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

HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

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

21st Century Themes
(www.21stcenturyskills.org)

__X_ Global Awareness
___Financial, Economic, Business and Entrepreneurial Literacy
_X__Civic Literacy
___Health Literacy
_X__Environmental Literacy

21st Century Skills

Learning and Innovation Skills:
_x__Creativity and Innovation
_X__Critical Thinking and Problem Solving
_X__Communication and Collaboration

Information, Media and Technology Skills:
__X_Information Literacy
__X_Media Literacy
__X_ICT (Information, Communications and Technology) Literacy

Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. NJSLSA.R1. Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. NJSLSA.R2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. NJSLSA.R4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone. NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. NJSLSA.R8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence. NJSLSA.R10. Read and comprehend complex literary and informational texts independently and proficiently with scaffolding as needed. NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. NJSLSA.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. NJSLSA.W3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	*Life and Career Skills:* _x__Flexibility and Adaptability _x__Initiative and Self-Direction _X_Social and Cross-Cultural Skills _X_Productivity and Accountability _x__Leadership and Responsibility

NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation. NJSLSA.W8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. NJSLSA.W9. Draw evidence from literary or informational texts to support analysis, reflection, and research. NJSLSA.W10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.	
Enduring Understandings: *Students will understand that . . .* *EU 1* The solar system is evolving over time. *EU 2* The objects in the solar system are diverse and interact with each other. *EU 3* Space exploration is integral to our understanding of the solar system.	**Essential Questions:** *EU 1* • What is the origin of the solar system? • How has the solar system changed over time and what has brought about these changes? • What is the fate of the solar system? *EU 2* • What makes a planet a planet? • How do other bodies interact with the planets and sun in the solar system? *EU 3* • Is there a purpose for a space program and does it benefit society? • Are there limits to space exploration?

Knowledge: *Students will know . . .* *EU 1* • that 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. (HS- ESS1-2) • that the solar nebula theory is strongly favored as an evolutionary scenario for the origin of the solar system. • the Sun and planets formed from an interstellar cloud of gas and dust. • there are different regions of the solar system, such as the inner region, outer region, and trans-Neptunian (Kuiper belt) region. • that rings of the Jovian planets did not always exist and were caused by tidal forces. • collisions were frequent in the early formation of the solar system, causing transformations of moons and planets. • that the Moon most likely formed from the collision between "Earth" and a relatively large object during the early solar system. • the Terrestrial planets may have formed from the combining of planetesimals, which formed protoplanets. *EU 2* • temperature caused the differences between the inner and outer planets. • the eight planets of our solar system can be categorized into either a Terrestrial planet or Jovian planet. • Terrestrial planets have some similar characteristics, such as size and density. • Terrestrial planets have some different characteristics, such as atmospheres, geology, weathering, magnetic fields, and moons. • Jovian planets have some similar characteristics, such as size, density, rings, magnetic fields, and large moons, and are composed mainly of hydrogen and helium. • most planets have natural satellites, which have large variability in their characteristics. • according to the International Astronomical Union (IAU), Pluto is classified as a dwarf (or minor) planet.	**Skills:** *Students will be able to . . .* *EU 1* • apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6) o compare and contrast the theories of the origin of the Solar System. o demonstrate how the law of conservation of angular momentum contributed to the formation of the solar system. o describe how gravity played a part in forming the planets and their rings. • evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5) o apply the concept of the Roche Limit to predict whether or not a moon could exist at a specific distance from its host planet. o analyze maps of Mars and the Moon to evaluate cratering patterns. o describe the different theories regarding the formation of the Moon and identify which one is most plausible. *EU 2* • apply the condensation sequence to the formation and composition of the planets. • describe the characteristics of the planets and moons in the solar system and list similarities and differences between each. • calculate celestial body sizes and densities. • distinguish between asteroids, meteoroids, comets, and their origins. • develop a definition of a planet and compare it to the definition provided by the International Astronomical Union (IAU) • categorize objects in the solar system according to the IAU guidelines. • analyze the effects and frequency of celestial bodies colliding with the Earth and Moon.

• an object, such as Pluto, that is located or discovered in the Kuiper Belt region of the solar system is considered a KBO (Kuiper Belt Object) and TNO (Trans-Neptunian Object).
• asteroids reside mainly in the Asteroid Belt, located between the orbits of Mars and Jupiter.
• comets originate from either the Kuiper Belt or Oort Cloud region of space and are called short or long period comets based on their origin and period of revolution.
• asteroids and comets somewhat vary in their composition.
• meteoroids create light streaks called meteors when they enter Earth's atmosphere and are considered meteorites when they hit the ground.
• in the past, there have been large planetary impacts that have significantly affected the Earth.
 	
EU 3
• having close proximity, or contact, with an object provides information which could not be determined in other ways.
• NASA is a public entity that spends money on various projects dedicated to exploring the Universe and advancing scientific knowledge.
• space programs such as the ESA, CNSA, RFSA, and JAXA exist and are funded by other countries.
• private space programs have been created and are funded by non-public entities for reasons that may be related to self-interest and capitalism.
• the development and advancement of rocket technology made orbiting the Earth and solar system exploration possible.
• the United States and USSR competed in an unofficial "space race" that affected the rate at which both space and general technology developed, and much of modern technology exists as a result of that "race."
• several NASA missions successfully enabled astronauts to explore the Moon for various reasons, which included bringing back samples of the surface for scientific study.
• unmanned space exploration, such as the Mars rovers and New Horizons missions, are beneficial to exploration by allowing close-up data collection of solar system objects without the need to plan for human travel.
	• debate whether it is probable that in the lifetime of a human, a significant impact to Earth will occur from a collision between Earth and space debris.
	
	EU 3
	• communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system, see list below) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)
	  ○ compare and contrast the pros and cons of manned versus unmanned space exploration.
	  ○ describe the success and failures of the various manned and unmanned space missions attempted by various space agencies.
	  ○ analyze the problems and setbacks that engineers might encounter when planning missions to planets and moons within the solar system.
	  ○ discuss how technological advances developed throughout and as a result of the space program.
	  ○ evaluate the success of private enterprise entering the space field.
	  ○ analyze how the current major goals in the space program can be beneficial to society.
	  ○ debate the advantages and associated costs inherent in a space exploration program.

• new evidence from current space exploration provides information to scientists that enables them to modify theories about and perspectives on the Universe. • water exists in some form on moons, planets, and space debris (i.e. comets) within our solar system, and not just on Earth.	

Stage 2 – Assessment Evidence

Other Recommended Evidence:

- Quizzes
- Summarizers
- Essays
- Research
- Presentations
- Formal lab write ups
- Discussions
- Kahoot it
- Diagrams
- Unit Test

Stage 3 – Learning Plan

Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: *Consider the WHERETO elements. Each learning activity listed must be accompanied by a learning goal of A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.*

- Students will brainstorm/ Think Pair Share: How was the solar system created? (A/M)
- Teacher-led discussion/notes on the theories of the catastrophic and evolutionary origins of the solar system. (A)
- Students will compare and contrast the theories of the origin of the Solar System. (A/M)
- Students will draw and explain the solar Nebula process. (A/M)
- Students will explain: Why planets and debris are aligned closely within the same plane? (A/M)
- Student Inquiry/Discussion: Terrestrial Planets vs. Jovian Planets (A/M)
- Students will create diagrams that compare and contrast Terrestrial planets and Jovian planets (A/M)
- Students will calculate celestial body sizes and densities. (A/M)
- Students will complete the *Virtual Astronomy Lab* computer activity: "Kepler's Laws and the Orbits of Moons" https://www.physicscurriculum.com/virtualastronomy/ (A/M/T)
- Students will complete the following: Starry Night Activities
  http://www.starrynighteducation.com/products-astronomy-education-high-school.html (A/ M/ T)
  C- The Planets
  C1: The Inner and Outer planets of the Solar System
  C2: Motion of the Planets
  C3: The Moons of the Planets
  C4: Pluto as a Dwarf Planet
- Students will create a diagram to distinguish between asteroids, meteoroids, comets, and their origins. (A/M)
- Students will complete the following: Starry Night Activities http://www.starrynighteducation.com/products-astronomy-education-high-school.html (A/ M/ T)
  D- Small Solar System Bodies
  D1: Asteroids of the Main Belt
  D2: Comets and Meteors
  D3: Impact: Near Earth Objects
- Students will develop a definition of a planet and compare it to the definition provided by the International Astronomical Union (IAU) (A/M)
- Students will categorize objects in the solar system according to the IAU guidelines. (A/M)
- Students will analyze the effects and frequency of celestial bodies colliding with the Earth and Moon. (A/M)
- Students will debate whether it is probable that in the lifetime of a human, a significant impact to Earth will occur from a collision between Earth and space debris.(M/T)
- Teacher-led Angular Momentum demonstrations (A/M)
- Students will analyze, given a map of the moon or mars, the craters and determine the size and and angle of impact.(M/T)

- Students will compare and contrast characteristics of Terrestrial and Jovian planets. (A/M)
- Students will make predictions about how much real estate and property would cost on a moon in the solar system and defend their reasoning. (M/T)
- Teacher-led discussion and notes about NASA and other space programs. (A)
- Students will compare and contrast the pros and cons of manned versus unmanned space exploration. (A/M/T)
- Students will describe the success and failures of the various manned and unmanned space missions attempted by various space agencies. (A/M)
- Students will create a list/timeline/summary of important scientific discoveries that occurred due to space exploration. (A/M)
- Students will analyze the problems and setbacks that engineers might encounter when planning missions to planets and moons within the solar system. (A/M)
- Students will identify/summarize technological advances that developed throughout and as a result of the space program. (A/M)
- Students will evaluate/debate the success of private enterprise entering the space field. (A/M/T)
- Students will complete the following: Starry Night Activities http://www.starrynighteducation.com/products-astronomy-education-high-school.html (A/ M/ T)
  I- Space Exploration and Technology
  I1: Artificial Satellites and the Space Environment
  I2: Great Explorations in the Solar System
  I3: Tools of the Astronomer
- Videos: Hidden Figures, The Martian, Apollo 13, The Right Stuff, Voyage to the Planets and Beyond, Europa Report. (A/M)
- Read Hidden Figures by Margot Lee Shetterly https://www.nasa.gov/sites/default/files/atoms/files/modernfigures_toolkit_interactive_0.pdf http://files.harpercollins.com/HarperAcademic/HC-808_HiddenFigures_TG_3.pdf , The Martian by Andy Weir http://images.randomhouse.com/teachers_guides/9780804189354.pdf, http://www.nea.org/tools/lessons/63667.htm , additional texts such as October Sky, Apollo 13, The Right Stuff. (A/M/T)
- National Geographic Series: Mars http://channel.nationalgeographic.com/mars/episode-guide/ http://media.nationalgeographic.org/assets/file/MARS_CURRICULUM_GUIDE_FORMSVERSION_ALL_FINAL.pdf (A/MT)
- Videos: The Universe http://www.history.com/shows/the-universe
  Crash Course Astronomy https://www.youtube.com/playlist?list=PL8dPuuaLjXtPAJr1ysd5yGIyiSFuh0mIL
  Through the Wormhole Series https://www.sciencechannel.com/tv-shows/through-the-wormhole/
  How the Universe Works https://www.sciencechannel.com/tv-shows/how-the-universe-works/
  The Cosmos Series http://channel.nationalgeographic.com/cosmos-a-spacetime-odyssey/ (A/M)