Unit 1 Birth and Evolution of Solar Systems

Content Area: **Science**
Course(s): **Astronomy 2**
Time Period: **February**
Length: **5 Weeks**
Status: **Published**

Enduring Understanding

Discuss the components of the solar system including the sun, planets, moons, asteriods and comets.

Explain how the planets form and what processes give them their characteristic features.

Explain how other planetary system have been discovered and how we have been able to learn about exoplanets.

Connect the concepts of radiation and the electromagnetic spectrum to the use of historical and newly-developed observational tools.

Essential Questions

What are the primary components of our solar and what are their distinctive properties?

What are the differences between terrestrial, Jovian, and dwarf planets, and their satellites and why Pluto was recently reclassified.?

How do astronomers measure masses and radii for bodies in the Solar System, and how do they carry out calculations to find a body's density from these measurements?

What are the steps in the formation of the Solar System according to the nebular theory and how are these related to the properties of the planets and other bodies?

How do astronomical observations of different kinds of light provide different kinds of information about the Solar System?

Content

Vocabulary

accretion, asteriod, asteriod belt, Bode's rule, comet, condensation, dwarf planet, exoplanet, gravitational lensing, inner planet, interstellar cloud, interstellar grain, Jovian planet, Kuiper belt, Oort cloud, outer planet, planetesimal, solar

nebula, sloar nebula theory, Solar System, terrestrial planet, transit

Skills

Describe the basic properties of the Lawa of Gravity.

Explain what density is, why it is important, and how it is calculated.

Describe the major regions of the electromagnetic spectrum and explain how Earth's atmosphere affects our ability to make astronomical observations at different wavelengths.

Explain Kepler's three Laws of Planetary Motion and describe how they are calculated.

Describe Bode's Rule and how it is used to determine the position of the planets.

Explain how computer simulations try to solve Newton's Laws of Motion in an effort to explain how solar systems form.

Discuss how we can test the proposal of migrating planets.

Explain the relation between emission and absorption lines and what we can learn from those lines.

Specify the basic components of the atom and describe our modem conception of its structure.

Discuss the observations that led scientists to conclude that light has particle as well as wave properties.

Explain how electron transitions within atoms produce unique emission and absorption features in the spectra of those atoms.

Describe the general features of spectra produced by molecules.

List and explain the kinds of information that can be obtained by analyzing the spectra of astronomical objects.

Sketch and describe the basic designs of optical telescopes used by astronomers.

Explain the particular advantages of reflecting telescopes for astronomical use
and specify why very large telescopes are needed for most astronomical studies.

Explain the purpose of some of the detectors used in astronomical telescopes.

Describe how Earth's atmosphere affects astronomical observations, and discuss
some of the current efforts to improve Ground-based astronomy.

Discuss the relative advantages and disadvantages of radio and optical astronomy.

Explain how interferometry can enhance the usefulness of astronomical observations.

Explain why some astronomical observations are best done from space, and discuss the advantages and limitations of space-based astronomy.

Say why it is important to make astronomical observations in different regions of the electromagnetic spectrum.

Resources

Standards

NGSS: Science Performance Expectations(2014)
NGSS: MS Earth & Space Science
MS.Space Systems
Performance ExpectationsShow details
MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.Show details

NGSS: HS Physical Sciences
HS.Waves and Electromagnetic Radiation
Performance ExpectationsShow details
HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.Show details

HS-PS4-3. Evaluate the claims, evidence, and reasoning behind behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.Show details

HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.Show details

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.*Show details

NGSS: Science and Engineering Practices
NGSS: 9-12
Practice 1. Asking questions (for science) and defining problems (for engineering)
Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Practice 2. Developing and using models
Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations
Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Select appropriate tools to collect, record, analyze, and evaluate data.

Practice 4. Analyzing and interpreting data
Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Practice 5. Using mathematics and computational thinking
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Practice 7. Engaging in argument from evidence
Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

NGSS: Crosscutting Concepts
NGSS: 9-12
Crosscutting Statements
1. Patterns – Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.

2. Cause and Effect: Mechanism and Prediction – Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

3. Scale, Proportion, and Quantity – In considering phenomena, it is critical to recognize what is relevant at

different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.
The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

4. Systems and System Models – A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
Systems can be designed to do specific tasks.

5. Energy and Matter: Flows, Cycles, and Conservation – Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.
Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Connections to the Nature of Science: Most Closely Associated with Crosscutting Concepts
Science is a Way of Knowing
Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise, and extend this knowledge.

NGSS: Disciplinary Core Ideas
NGSS: 9-12
ESS1: Earth's Place in the Universe
ESS1.A: The Universe and Its Stars
The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1)

The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3)

The Big Bang theory is supported by observations of distant galaxiesreceding 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.(HSESS1-2)

PS1: Matter and Its Interactions
PS1.A: Structure and Properties of Matter
Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)

PS1.C: Nuclear Processes
Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption ofenergy. The total number of neutrons plus protons does notchange in any nuclear process. (HSPS1-8)

PS2: Motion and Stability: Forces and Interactions
PS2.A: Forces and Motion
Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)

PS3: Energy
PS3.A: Definitions of Energy
Energy is a quantitative property of a system that depends on the motionand interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HSPS3-1),(HS-PS3-2)

PS3.C: Relationship Between Energy and Forces
When two objects interacting through a field change relative position, theenergy stored in the field is changed. (HS-PS3-5)

PS4: Waves and Their Applications in Technologies for Information Transfer
PS4.B: Electromagnetic Radiation
Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.(HS-PS4-3)

SCI.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.
SCI.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.
SCI.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.
SCI.HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
SCI.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
SCI.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.
SCI.HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
SCI.HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
SCI.HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
SCI.HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
SCI.HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
SCI.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.
SCI.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).