TABLE OF CONTENTS

UNIT NARRATIVE

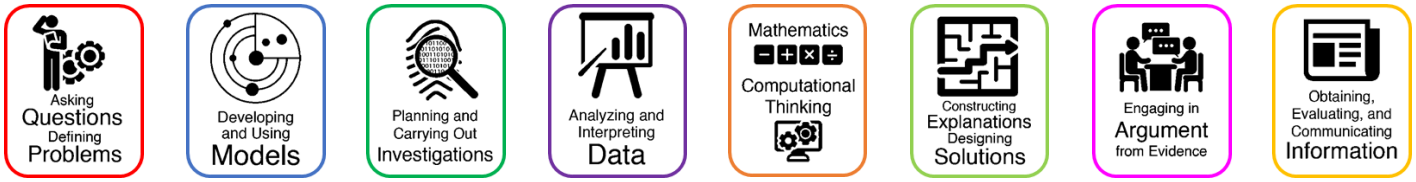
Unit 3 will center wound the readiness standard 8.9A (Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram) and will begin with the students describing what they think happens when a star "dies." The unit will culminate with students completing a formative assessment task to analyze a binary star system and predict, based on knowledge gained during the unit, what life on Earth would be like if our Solar System was a binary star system.

After the unit launch in lesson 1, students will explore the life cycle of stars in lesson 2. In lessons 3 -5. Students will use H-R diagrams to classify stars based on their luminosity and temperature. In lesson 6, students will categorize galaxies based on their shape (spiral, elliptical, and irregular) and in lesson 7 will locate Earth's Solar System on the spiral shaped Milky Way galaxy. In lesson 8, students will analyze scientific data that describes the origin of the universe. In lessons 9 and 10, students will focus on the solar system, and how gravity governs the motion of the components of the solar system. In lessons, 11-13 students will model and illustrate how the tilted Earth revolves around the Sun, causing changes in seasons. Finally, in lessons 14- 16 students will describe and predict how the positions of the Earth, Sun, and Moon cause, daily, spring and neap cycle of tides. Lesson 17 will be the formative assessment task and lesson 18 will be flex time.

The best science instruction practice is to remember ABC (activity before concept) and CBV (concept before vocabulary.) Students need to engage in investigation, discourse, reading, and writing to discover science concepts not being told the science content. We want students to be doing science, not memorizing science. This may be counter-intuitive to you and may not be the way you learned science, but research proves this is best practice for instruction and learning

Focus on Disciplinary Literacy

In science, disciplinary literacy is synonymous with the science and engineering practices. The SEPs are the context through which all science concepts should be taught. In the lessons, you will find the Science and Engineering practices icons when the SEPs are being explicitly used by students.



CONTENT

STANDARDS

Below are the standards **taught** and **assessed** in this unit.

Readiness Standards
8.9A Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram.
Supporting Standards
8.9B Categorize galaxies as spiral, elliptical, and irregular and locate Earth's solar system within the Milky Way galaxy. 7.9B describe how gravity governs motion within Earth's solar system. 6.9A model and illustrate how the tilted Earth revolves around the Sun, causing changes in seasons. 6.9B describe and predict how the positions of the Earth, Sun, and Moon cause daily, spring, and neap cycles of ocean tides due to gravitational forces.
Other Non-Test Standards Reviewed in this Unit
8.9C Research and analyze scientific data used as evidence to develop scientific theories that describe the origin of the universe.

UNDERSTANDINGS AND QUESTIONS

Important big ideas and processes for the unit.

Key Understandings
• Stars change overtime (Lesson 01) • Different types of stars have different physical properties. (Lesson 02) • All stars have a life cycle, and that life cycle is based on the star's mass. A star's mass not only determines how long a star will live but also the path of the specific stages it will follow throughout its life span. (Lesson 02) • Stars are the primary sources for making and distributing heavier elements throughout the universe. (Lesson 02) • Astronomers study the spectrum of stars because it provides crucial information about the stars' properties, composition, and behavior. (Lesson 03) • H-R diagram is a graphical plot astronomers use to classify and interpret the life cycles of stars. (Lessons 04 and Lessons 05) • Astronomers categorize galaxies based on their structure and arrangement of stars. The three main types of galaxies are spiral, elliptical, and irregular. (Lesson 06)

- Astronomers categorize galaxies based on their structure and arrangement of stars. The three main types of galaxies are spiral, elliptical, and irregular. (Lesson 07)
- Earth's solar system is located on the Orion Arm (Orion Spur) of the Milky Way galaxy. (Lesson 07)
- The Big Bang theory is a well-supported explanation for the origin of the universe, and it is backed by key scientific evidence, such as the cosmic microwave background radiation and the redshift of galaxies. (Lesson 08)
- Two factors determine the magnitude of the gravitational force between two objects: (Lesson 09)
  1. their masses and
  2. the separation distance between them.
- The Sun is the most massive object in our solar system and overs the motion of all the other objects in the system by the force of gravity. The objects in the Solar System are in motion and maintain that motion because of inertia. If the objects were not in constant motion, the pull of gravity would draw them into the Sun. If there were no gravity the object would continue moving in a straight line into outer space. (Lesson 09 and 10)
- Gravity is the force by which a planet or other body draws objects toward its center. Anything with mass has gravity, and objects with more mass have more gravity. Lesson 09 and 10)
- Earth has seasons because its axis is tilted. Earth's axis is always pointed in the same direction, so different parts of Earth get the Sun's direct rays throughout the year. (Lessons 12 & 13)
- As Earth rotates on its axis, the Moon exerts a gravitational pull-on Earth. Inertia acts as a counterbalance to the gravitational forces. Gravity and inertia are responsible for the creation of two ocean tidal bulges on opposite sides of Earth. This creates a predictable schedule of high tides and low tides that coincides with the lunar cycle. (Lesson 15)
- The position of the Moon and Sun affects tides causing spring and neap tides. When the Sun and Moon and in a horizontal alignment with the Earth (Full or New Moon) the result is a spring tide. When the Moon is perpendicular (first quarter or last quarter) to the Sun the result is a neap tide. (Lesson 16)

Key Questions

- Why don't all stars have the same physical properties? (Lesson 01)
- How do scientists use data to predict the life of a star? (Lesson 02)
- Are all stars the same? (Lesson 03)
- How do scientists know the difference in the temperature of stars? (Lesson 03)
- How is the color of a star related to its temperature? (Lessons 04 and Lessons 05)
- How are a star's luminosity, mass, and radius related? (Lessons 04 and Lessons 05)
- What does an H-R diagram reveal about star types? (Lessons 04 and Lessons 05)
- What are galaxies? (Lesson 06)
- How are galaxies classified? (Lesson 06)
- Where in the Milky Way galaxy is Earth's Solar System located? (Lesson 07)
- What is the Big Bang? (Lesson 08)
- What evidence could we possibly have from something that took place over 13 billion years ago? (Lesson 08)
- What factors affect the magnitude of the force of gravity? (Lesson 09)

- In what ways does gravity govern the motion of our solar system? (Lesson 10)
- Why does the Sun's gravity not pull the planets into it? (Lesson 10)
- Why do planets not fly off into outer space? (Lesson 10)
- In what ways are gravity, mass, and distance related? (Lesson 10)
- What causes the seasons to change on Earth? (Lessons 12 & 13)
- If the tilt of the Earth constantly changed, how would it affect the seasons? (Lessons 12 & 13)
- Why do you think there is such a large misconception about why the Earth has seasons? (Lessons 12 & 13)
- How are gravity and inertia responsible for Earth's tides? (Lesson 15)
- What is high tide? What is low tide? How do the high and low tides relate to Earth's rotation? (Lesson 15)
- Is there a relationship between the lunar cycle and tides? (Lesson 16)

Common Misconceptions

- Thinking that stars follow a linear life cycle from birth to death, with every star going through the same stages. (Lessons 01 and 02)
- Assuming all stars, regardless of their mass, end up as black holes. (Lessons 01 and 02)
- All stars are the same. (Lesson 03)
- All stars appear white. (Lesson 03)
- Stars only look different because of the distance they are from Earth. (Lesson 03)
- Thinking stars get dimmer as they get older. (Lessons 04 and Lessons 05)
- Thinking stars get cooler as they get older. (Lessons 04 and Lessons 05)
- Thinking that the temperature scale on the H-R diagram is linear, similar to a typical number line (Lessons 04 and Lessons 05)
- Thinking that the data points on an H-R diagram represent stars that are physically close together in space (Lessons 04 and Lessons 05)
- Thinking that all galaxies have a uniform appearance (i.e. failing to recognize the diversity of shapes and structures among spiral, elliptical, and irregular galaxies) (Lesson 06)
- Thinking that galaxies are static and unchanging rather than dynamic and evolving over time (Lesson 06)
- Thinking that galaxies are much closer together than they are, not accounting for the universe's immense scale. (Lesson 06)
- Students may struggle comprehending the immense size and distance of galaxies as well as the vastness of space (Lesson 06)
- Thinking of a light-year is a measurement of time. (Lesson 07)
- Thinking that Earth is located at the center of the Milky Way galaxy. (Lesson 07)
- Students may struggle comprehending the immense size and distance of galaxies as well as the vastness of space (Lesson 07)
- Thinking that the universe has always existed in its current form and has no beginning or end (Lesson 08)
- Thinking that there is only one theory for the origin of the universe (Lesson 08)
- Thinking of the big bang as an explosion that occurred within pre-existing space rather than the expansion of space itself (Lesson 08)
- Thinking that the big bang was an event that happened in the past and not recognizing the expansion of the universe is an ongoing process (Lesson 08)
- Thinking that the big bang theory explains everything in the universe (Lesson 08)

ROADMAP

ROADMAP AT A Glance: Unit 4 - The Universe				
Day	**Date**	**TEKS**	**Lesson**	**Lesson Title**
There is one flex day built into this unit to use as needed. Flex days can be used for lessons that take longer than one day or for reteaching material the students may not have gotten during tier 1 instruction.				
1			01	Unit Introduction
2		8.9A	02	Life Cycle of a Star
3		8.9A	03	Classifying Stars – HR Diagrams Part 1
4		8.9A	04	Classifying Stars – HR Diagrams Part 2
5		8.9A	05	Classifying Stars – HR Diagrams Part 3
6		8.9B	06	Galaxies
7		8.9B	07	The Milky Way
8		8.9C	08	Origin of the Universe
9		7.9B	09	Gravity and the Solar System Part 1
10		7.9B	10	Gravity and the Solar System Part 2
11		6.9A	11	Tilted Earth and Seasons Part 1 (Optional)
12		6.9A	12	Tilted Earth and Seasons Part 2
13		6.9A	13	Tilted Earth and Seasons Part 3
14		6.9B	14	Phases of the Moon Review (Optional)
15		6.9B	15	Tides Part 1
16		6.9B	16	Tides Part 2
			Unit Exam	TX_SCI_8thScience_F25_UE4 Scanning Deadline:

Lesson #01: Unit Introduction	Date:

Objective

SWBAT desribe the life cycle of stars and determine the star's outcome by analyzing its initial mass

Standards

TEKS

8.9A Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram.

Vocabulary

None

Science Practices

1. Asking questions and defining problems
2. Developing and using models

Recurring Themes and Concepts

A. Patterns

Instructional Notes

- Students will watch a video showing a star exploding to formulate questions about how stars change over time.
- Students will analyze diagrams and the names of the various stages of average stars and massive stars. Students will put the cards in order based on observations only and be asked to justify their thinking.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.

☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle

☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Students will analyze diagrams and the names of the various stages of average stars and massive stars. Students will put the cards in order based on observations only and be asked to justify their thinking.

- Stars change over time.

Lesson #2: Life Cycle of a Star	Date:

Objective

SWBAT desribe the life cycle of stars and determine the star's outcome by analyzing its initial mass

Standards

TEKS

8.9A Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram.

Vocabulary

Black Dwarf	Black Hole
Main Sequence	Neutron Star
Nuclear Fusion	Planetary Nebula
Protostar	Red Giant
Red Supergiant	Star
Stellar Nebula	Supernova
White Dwarf	

Science Practices

1. Asking questions and defining problems
2. Developing and using models
7. Engaging in argument from evidence

Recurring Themes and Concepts

A. Patterns

Instructional Notes

- Students will revisit the life cycle of a star activity from lesson 1. This time students will be given description cards to help them arrange the cards.
- Students will participate in a reading to learn to deepen their understanding of the stages in a star's life cycle.
- Students will describe the life cycle of stars and determine the star's outcome by analyzing its initial mass.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.

☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle

☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Revisit the life cycle of a star activity from lesson 1. This time students will be given description cards to help them arrange the cards.
- Participate in a reading to learn to deepen their understanding of the stages in a star's life cycle.
- Describe the life cycle of stars and determine the star's outcome by analyzing its initial mass.

- All stars have a life cycle, and that life cycle is based on the star's mass. A star's mass not only determines how long a star will live but also the path of the specific stages it will follow throughout its life span.
- Stars are the primary sources for making and distributing heavier elements throughout the universe.

Lesson #03: Classifying Stars HR Diagrams Part 1	Date:

Objective

SWBAT Describe a stars' physical characteristics such as surface teperature and color by determing the spectral lines present in the star's spectrum.

Standards

TEKS

8.9A Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram.

Vocabulary

Absorption Spectrum
Emission Spectrum
Spectrum

Science Practices

1. Asking questions and defining problems
2. Developing and using models

Recurring Themes and Concepts

A. Patterns

Instructional Notes

- Students will revisit the flame test video they saw in unit 1 and review the light given off when different elements are heated.
- Students will examine simplified stellar spectra and determine which elements are present in the spectrum. Students will then use the Harvard Classification Scheme to classify the star and estimate its surface temperature.
- Describe a stars' physical characteristics such as surface teperature and color by determing the spectral lines present in the star's spectrum.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.

☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle

☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Examine simplified stellar spectra and determine which elements are present in the spectrum. Students will then use the Harvard Classification Scheme to classify the star and estimate its surface temperature.
- Describe a stars' physical characteristics such as surface teperature and color by determing the spectral lines present in the star's spectrum.

- The spectrum of a star shows lines that correspond to different elements. By analyzing these lines, astronomers can identify the elements present in a star's atmosphere and determine its chemical makeup.
- The spectrum reveals the temperature of a star. Different elements emit and absorb light at specific wavelengths depending on temperature and indicate the star's surface temperature

Lesson #04: Classifying Stars HR Diagrams Part 2	Date:

Objective

SWBAT describe and compare characteristics of stars such as main sequence, giant, supergiant, and white dwarf stars by interpreting an HR Diagram

Standards

TEKS

8.9A Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram.

Vocabulary

HR Diagram
Luminosity

Science Practices

1. Asking questions and defining problems
2. Developing and using models

Recurring Themes and Concepts

A. Patterns
C. Scale, Proportion, Quantity

Instructional Notes

- Students will use a simulation to identify relationships between different star characteristics, classify stars based on their color, temperature, luminosity, radius, and mass, and use an H-R diagram to describe characteristics of main sequence, giant, supergiant, and white dwarf stars.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle
☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Identify relationships between different star characteristics.
- Classify stars based on their color, temperature, luminosity, radius, and mass.
- Use an H-R diagram to describe characteristics of main sequence, giant, supergiant, and white dwarf stars.

- In main sequence stars, luminosity increases significantly as the mass of the star increases.
- In main sequence stars, temperature increases as the mass of the star increases.
- A star's luminosity generally increases over time, especially as it leaves the main sequence, and may decrease significantly in its final stages depending on its mass and evolution.

Lesson #05: Classifying Stars HR Diagrams Part 3	Date:

Objective

SWBAT describe and compare characteristics of stars such as main sequence, giant, supergiant, and white dwarf stars by interpreting an HR Diagram

Standards

TEKS Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram

Vocabulary

Absolute Magnitude
Apparent Magnitude
HR Diagram
Luminosity

Science Practices

2. Developing and using models
4. Analyzing and interpreting data
8. Obtaining, evaluating, and communicating information

Recurring Themes and Concepts

A. Patterns
C. Scale, Proportion, Quantity
D. Systems and System Models

Instructional Notes

- Students will review the characteristics of stars such as chemical composition, color, size, color, temperature, and brightness.
- students will Complete a reading to learn to deepen their understanding of HR diagrams.
- Students will plot starts on a HR diagram
- Students will classify stars and describe stars characteristics by interpreting a HR diagram.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.

☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle

☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Students will classify stars and describe stars characteristics by interpreting a HR diagram.

- An H-R diagram is a graphical plot astronomers use to classify and interpret the life cycles of stars

Lesson #06: Galaxies	Date:

Objective

SWBAT Categorize galaxies as spiral, elliptical, and irregular by analyzing images and characteristics.

Standards

TEKS Categorize galaxies as spiral, elliptical, and irregular and locate Earth's solar system within the Milky Way galaxy

Vocabulary

Elliptical Shaped Galaxy
Galaxy
Irregular Shaped Galaxy
Spiral Shaped Galaxy

Science Practices

2. Developing and using models
8. Obtaining, evaluating, and communicating information

Recurring Themes and Concepts

A. Patterns
F. Structure and Function

Instructional Notes

- Students complete a card sort and attempt to group galaxies based on characteristics they observe, then they will participate in a reading to learn more about the structure of galaxies, finally they will resort their cards into the three types of galaxies, spiral, elliptical, and irregular.
- Students will compare the characteristics of spiral, elliptical and irregular shaped galaxies.
- Students will categorize galaxies as spiral, elliptical, and irregular by analyzing images and characteristics.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle
☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Students will categorize galaxies as spiral, elliptical, and irregular by analyzing images and characteristics.

- Astronomers categorize galaxies based on their structure and arrangement of stars. The three main types of galaxies are spiral, elliptical, and irregular.

Lesson #07: The Milky Way	Date:

Objective

SWBAT

Standards

TEKS Categorize galaxies as spiral, elliptical, and irregular and locate Earth's solar system within the Milky Way galaxy

Vocabulary

Milky way Galaxy
Galactic Center
Orion Arm

Science Practices

2. Developing and using models
8. Obtaining, evaluating, and communicating information

Recurring Themes and Concepts

C. Scale, Proportion, Quantity

Instructional Notes

- Students will participate in a demo to understand the concept of a light year.
- Students will watch a 5-minute video to learn more about the Milky Way galaxy.
- Students will read more about the Milky Way galaxy and learn the location of the Solar System.
- Students will label the parts of the Milky Way diagram including the arms, central bulge, and location of the solar system as well as the distances of the width and thickness.
- Students will identify and describe the location of Earth's solar system in the Orion Arm (Orion Spur) of the Milky Way galaxy by analyzing diagrams.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle
☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Students will label the parts of the Milky Way diagram including the arms, central bulge, and location of the solar system as well as the distances of the width and thickness.
- Students will identify and describe the location of Earth's solar system in the Orion Arm (Orion Spur) of the Milky Way galaxy by analyzing diagrams.

- Earth's solar system is located on the Orion Arm (Orian Spur) of the Milky Way galaxy.

Lesson #8: Origin of the Universe	Date:

Objective

SWBAT identify the big bang theory as one of the theories that describes the origin of the universe by describing how evidence such as cosmic microwave background radiation and the redshift of galaxies supports the theory.

Standards

TEKS 8.9C Research and analyze scientific data used as evidence to develop scientific theories that describe the origin of the universe.

Vocabulary

Big Bang Theory
Cosmic Wave Background
Redshift

Science Practices

2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
8. Obtaining, evaluating, and communicating information

Recurring Themes and Concepts

G. Stability and Change

Instructional Notes

- Students will examine past and current theories about the nature and origin of the universe and investigate the phenomenon of redshift, a critical piece of evidence in many current theories.
- Students will read more about the evidence that supports the Big Bang theory and create a model to demonstrate the big bang.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle
☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Examine past and current theories about the nature and origin of the universe and investigate the phenomenon of redshift, a critical piece of evidence in many current theories.
- Read more about the evidence that supports the Big Bang theory and create a model to demonstrate the big bang.

- The Big Bang theory is a well-supported explanation for the origin of the universe, and it is backed by key scientific evidence, such as the cosmic microwave background radiation and the redshift of galaxies.

Lesson #9: Gravity and Solar System Part 1	Date:

Objective

SWBAT determine that factors that affect gravitational pull.

Standards

TEKS describe and predict how the positions of the Earth, Sun and moon cause daily, spring, and neap cycles of ocean tides due to gravitational forces.

Vocabulary

Magnitude
Gravitational Pull

Science Practices

1. Asking questions and defining problems
2. Developing and using models
4. Analyzing and interpreting data
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence

Recurring Themes and Concepts

Cause and Effect

Instructional Notes

Students will use a Phet simulation and explore how changing the mass of objects and the distance between those two objects affects the magnitude of the force of gravity.

Lesson Look Fors

Look for teachers to:

- ☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
- ☐ Promote the use of partners and whole class discussion.

Look or students to:

- ☐ Engage in discourse and productive struggle
- ☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Complete a simulation to determine what factors affect the magnitude of gravitational force between 2 objects.

Two factors determine the magnitude of the gravitational force between two objects:

1. their masses and
2. the separation distance between them.

Lesson #10: Gravity and Solar System Part 2	Date:

Objective

SWBAT explain how gravitational forces and the constant motion of objects govern motion with the Solar System

Standards

TEKS describe how gravity governs motion within Earth's solar system

Vocabulary

Gravity
Inertia
Orbit
Orbital Velocity
Revolution

Science Practices

2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking

Recurring Themes and Concepts

Patterns

Instructional Notes

- Students will review the concepts of inertia and gravity and apply their knowledge of these concepts to planets in the thinking task.
- Students will model the concepts of inertia and gravity acting upon a planet.
- Students will engage in a reading to learn to further their understanding of how inertia and gravity govern the motion of objects in space.
- Students will investigate how gravity, mass, and weight are related.
- Students will describe how the planets orbit the Sun in an elliptical path and draw a model to support your explanation.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle
☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Students will model the concepts of inertia and gravity acting upon a planet.
- Students will investigate how gravity, mass, and weight are related.

The Sun is the most massive object in our solar system and overs the motion of all the other objects in the system by the force of gravity. The objects in the Solar System are in motion and maintain that motion because of inertia. If the objects were not in constant motion the pull of gravity would draw them into the Sun. If there were no gravity the object would continue moving in a straight line into outer space.

Lesson #11: Tilted Earth and Seasons Part 1 (Optional)	Date:	
Objective	Instructional Notes	**Lesson Look Fors**
SWBAT understand the importance of experimental design and describe the different types of scientific investigations. **Standards** **TEKS** 6.1B- use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems **Vocabulary** **Science Practices** **Recurring Themes and Concepts**	Students are learning how to conduct experimental design and identify the three different types of scientific investigation. Students are practicing identifying independent and dependent variables, constants, and formulating hypotheses.	**Look for teachers to:** ☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss. ☐ Promote the use of partners and whole class discussion. **Look or students to:** ☐ Engage in discourse and productive struggle ☐ Justify their reasoning and support their ideas with evidence. **Students Do and Know** 

Lesson #12: Tilted Earth and Seasons Part 2	Date:

Objective

SWBAT investigate how the seasons change based on the tilt of Earth's axis.

Standards

TEKS 6.9A- model and illustrate how the tilted Earth revolves around the Sun, causing changes in seasons;

Vocabulary

Axis
Seasons
Latitude
Longitude

Science Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence

Recurring Themes and Concepts

Patterns

Instructional Notes

Students will investigate why the Earth has four seasons and understand that it has to do with the tilt of the Earth's axis.

By conducting the experiment students are simulating how the Earth rotates on its axis and how the four seasons are determined based on the Earth's position.

Lesson Look Fors

Look for teachers to:

- ☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
- ☐ Promote the use of partners and whole class discussion.

Look or students to:

- ☐ Engage in discourse and productive struggle
- ☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

Students will investigate why the Earth has four seasons and understand that it has to do with the tilt of the Earth's axis.

Earth has seasons because its axis is tilted. Earth's axis is always pointed in the same direction, so different parts of Earth get the Sun's direct rays throughout the year.

Lesson #13: Tilted Earth and Seasons Part 3	Date:

Objective

SWBAT investigate how the seasons change based on the tilt of Earth's axis.

Standards

TEKS

Vocabulary

6.9A- model and illustrate how the tilted Earth revolves around the Sun, causing changes in seasons;

Science Practices

1. Asking questions and defining problems
2. Developing and using models
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence

Recurring Themes and Concepts

Patterns

Instructional Notes

Students will investigate why the Earth has four seasons and understand that it has to do with the tilt of the Earth's axis.

Students will engage in a reading to learn and modeling activity and apply data they collected from yesterday's investigation. Students will then write a scientific explanation in CER format to answer the question, "What causes the Seasons on Earth."

Lesson Look Fors

Look for teachers to:

- ☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
- ☐ Promote the use of partners and whole class discussion.

Look or students to:

- ☐ Engage in discourse and productive struggle
- ☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

Students will engage in a reading to learn and modeling activity and apply data they collected from yesterday's investigation. Students will then write a scientific explanation in CER format to answer the question, "What causes the Seasons on Earth."

- Earth has seasons because its axis is tilted. Earth's axis is always pointed in the same direction, so different parts of Earth get the Sun's direct rays throughout the year

Lesson #14: Phases of the Moon (Optional)	Date:

Objective

SWBAT demonstrate and predict the sequence of events in the lunar cycle as they relate to tides.

Standards

TEKS 6.9B describe and predict how the positions of the Earth, Sun, and moon cause daily, spring, and neap cycles of ocean tides due to gravitational forces.

Vocabulary

New Moon
First Quarter Moon
Full Moon
Hird Quarter Moon

Science Practices

1. Asking questions and defining problems
2. Developing and using models
6. Constructing explanations and designing solutions

Recurring Themes and Concepts

Patterns

Instructional Notes

- Students use a simulation to see that the Sun, Earth and Moon work as a system with fixed rotation and revolution motions that result in observable and measurable patterns such as the events in the lunar cycle.
- Students will describe how the positions of the Earth, Sun, and Moon cause changes in the appearance of the Moon from Earth.
- Students will analyze a calendar to sequence lunar events.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.
☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle
☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Students will describe how the positions of the Earth, Sun, and Moon cause changes in the appearance of the Moon from Earth.

The predictable schedule of high tides and low tides coincides with the lunar cycle.

Lesson #15: Tides Part 1	Date:

Objective

SWBAT relate the position of the Moon it is effect on high and low tides.

Standards

TEKS 6.9B describe and predict how the positions of the Earth, Sun, and moon cause daily, spring, and neap cycles of ocean tides due to gravitational forces.

Vocabulary

High Tide
Low Tide
Inertia

Science Practices

1. Asking questions and defining problems
2. Developing and using models
4. Analyzing and interpreting data
6. Constructing explanations and designing solutions

Recurring Themes and Concepts

Patterns

Instructional Notes

- Students will create a graph using high and low tide data for a day and look for trends
- Students will create a model and explore the model to see how the Moon, Earth, Sun and Ocean interact.
- Students will complete and reading to learn to understand more about how the pull of gravity and inertia cause tidal bulges

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.

☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle

☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Students will create a graph using high and low tide data for a day and look for trends
- Students will create a model and explore the model to see how the Moon, Earth, Sun and Ocean interact.

As Earth rotates on its axis, the Moon exerts a gravitational pull-on Earth. Inertia acts as a counterbalance to the gravitational forces. Gravity and inertia are responsible for the creation of two ocean tidal bulges on opposite sides of Earth. This creates a predictable schedule of high tides and low tides that coincides with the lunar cycle.

Lesson #16: Tides Part 2	Date:

Objective

SWBAT relate the position of the Moon and Sun to their effects on spring and neap tides using models and graphs.

Standards

TEKS 6.9B describe and predict how the positions of the Earth, Sun, and moon cause daily, spring, and neap cycles of ocean tides due to gravitational forces.

Vocabulary

Science Practices

1. Asking questions and defining problems
2. Developing and using models
4. Analyzing and interpreting data
6. Constructing explanations and designing solutions

Recurring Themes and Concepts

Patterns

Instructional Notes

- Students will analyze two tidal data graphs and look for patterns in the tidal ranges.
- Students will then locate new, first-quarter, full, and third-quarter moons on a tidal calendar moon phases graph.
- Students will compare the moon phases to the various tidal ranges to see that large tidal ranges occur when full and new moons occur, and smaller tidal ranges occur when quarter moons occur.
- Students will learn the vocabulary spring and neap tides and see that it is the position of the Sun and Moon and their gravitational pulls wither working with each other or against each other, that causes the spring and neap tides.

Lesson Look Fors

Look for teachers to:

☐ Engage students in ABC. (Activity before content) The teacher should stamp key points AFTER students have had the time to engage in the content (productive struggle) and discuss.

☐ Promote the use of partners and whole class discussion.

Look or students to:

☐ Engage in discourse and productive struggle

☐ Justify their reasoning and support their ideas with evidence.

Students Do and Know

- Students will analyze two tidal data graphs and look for patterns in the tidal ranges.
- Students will then locate new, first-quarter, full, and third-quarter moons on a tidal calendar moon phases graph.
- Students will compare the moon phases to the various tidal ranges to see that large tidal ranges occur when full and new moons occur, and smaller tidal ranges occur when quarter moons occur.

The position of the Moon and Sun affects tides causing spring and neap tides. When the Sun and Moon and in a horizontal alignment with the Earth (Full or New Moon) the result is a spring tide. When the Moon is perpendicular (first quarter or last quarter) to the Sun the result is a neap tide

UNPACKED STANDARDS

Focus standards for this unit.

Standard:	8.9A Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram.

Specificity

Cognition: Describe
Content: the life cycle of stars
Including, but not limited to:

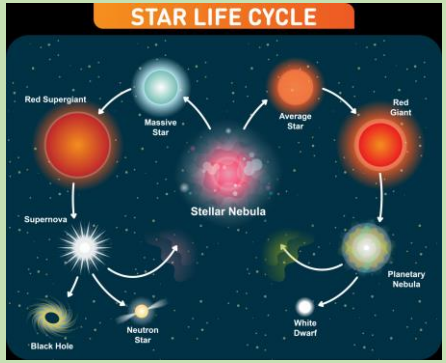
- Stars – Their life cycle depends on their size.
  - Made mostly of hydrogen and helium gas
    - Classified by size, temperature, and brightness
    - Types of stars: Main Sequence, White Dwarfs, Red Giants, Supergiants, and Blue Giants
- Nebula – a cloud of dust and gas
  - Birthplace of stars
- Protostar
- Main sequence
- After the main sequence, the life cycle depends on the size of the star.
  - Stars similar to the Sun become a:
    - Red giant
    - White dwarf
    - Black dwarf
  - Stars larger than the Sun become a:
    - Red supergiant
    - Supernova
    - Neutron star or black hole, depending on size

Cognition: Compare and classify
Content: stars using the Hertzsprung-Russell Diagram
Including, but not limited to:

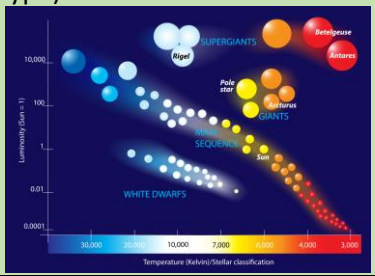
- Hertzsprung-Russell (H-R) diagram
  - Relationship between brightness, surface temperature, and color
- Magnitude (luminosity)
  - Apparent
  - Absolute
  - Located on the y-axis

Content Builder

The life cycle of stars is determined by their mass and can last from millions to billions of years.
Stars are formed inside nebulae, which are hot clouds of gas and dust. A protostar is formed in the nebula as it spins and its materials slowly condense. As these materials get packed more and more tightly together, the temperature rises, creating a protostar and eventually a star. If its temperature is warm enough for the fusion of hydrogen to begin, it then enters the main part of its life, known as the main sequence stage. A star can take one of two routes; it can and become either an average or a massive star.



The Hertzsprung- Russell (H-R) diagram classifies stars based on their luminosity (brightness) and temperature (color). It helps us understand the stages of stellar evolution. On the H-R diagram, luminosity is shown on the vertical axis, and temperature (or spectral type) is on the horizontal axis.



Instructional Implications

- Dimmer stars are closer to the axis; brighter stars are farther away from the origin.
- Temperature
  - Hotter = blue or white
  - Cooler = red
  - Located on the x-axis
  - Hotter temperatures are closest to the origin.
  - Cooler temperatures are farther away from the origin.
  - Spectral classes

Possible STAAR Stimuli

Investigation	Chart/Table	Diagram
Visual/Image/ Illustration	Web/Cycle/Chain	Model
Informational Text/List*		

When you teach this concept, remember to:

- Use visuals (e.g., models, diagrams, animations, and illustrations) to show the stages of the life cycle of stars and the H-R diagram.
- Engage students in hands-on activities that simulate stellar evolution and the creation of H-R diagrams. Students can create their own diagrams using data from various stars and classify them.
- Explore real-life examples of stars at different life cycle stages; discuss how these stars fit into the H-R diagram and what it reveals about their properties.
- Use interactive tools or computer simulations to explore the H-R diagram and understand how different factors influence a star's position on it.
- Help students see the Recurring Theme and Concept of patterns in this standard.

Student Misconceptions

- Students may struggle to interpret the labels on the axes and grasp the significance of each value.
- Thinking that the temperature scale on the H-R diagram is linear, similar to a typical number line
- Thinking that the data points on an H-R diagram represent stars that are physically close together in space
- Thinking that stars follow a linear life cycle from birth to death, with every star going through the same stages
- Assuming all stars, regardless of their mass, end up as black holes.

Standard:	8.9B Categorize galaxies as spiral, elliptical, and irregular and locate Earth's solar system within the Milky Way galaxy.

Specificity

Cognition: Categorize
Content: galaxies as spiral, elliptical, and irregular
Including, but not limited to:

- Galaxy – a system of stars and associated matter, held together by gravitational attraction
  - Types of galaxies:
    - Elliptical – oval-shaped
    - Spiral – pinwheel-shaped
      - Milky Way (includes Earth)
    - Irregular – no symmetry

Cognition: Locate
Content: the solar system within the Milky Way galaxy
Including, but not limited to:

- Our solar system
  - The Sun
  - Planets including Earth
- Our Galaxy
  - Called the Milky Way
  - Spiral-shaped
  - The Sun is about half the distance from the center of the galaxy to the outer edge in a small spiral arm.

Instructional Implications

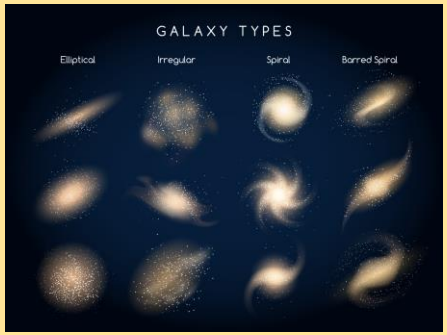
When you teach this concept, remember to:

- Use visuals such as images, diagrams, and models to show the shapes of spiral, elliptical, and irregular galaxies.
- Involve students in hands-on activities where they classify and draw examples of each galaxy type.
- Show real-life images and examples of galaxies from space telescopes or astronomical observations.
- Let students explore and categorize galaxies using interactive tools or computer simulations.
- Represent the size of the Milky Way galaxy and Earth's position within it using a scale model.
- Emphasize the vastness of space by discussing astronomical units and light-years.

Content Builder

Galaxies are massive systems of stars, remnants of stars, and clouds of gas, dust, and dark matter. They are held together by gravity. Supermassive black holes are at the center of most galaxies. The word galaxy is derived from the Greek word for milky, referring to the Milky Way. There are more than 170 billion observable galaxies in the universe. There is a wide range of galaxy shapes and sizes. The classifications of galaxies, based on their shapes, are elliptical, spiral, and irregular. The three types of galaxies can be described as follows:

- Elliptical galaxies are long and oval in shape. They have a bright center, very little dust or gas, and no apparent internal structure or spiral arms.
- Irregular galaxies have very little symmetry and do not fit into any other category.
- Spiral galaxies, including barred spiral galaxies, have a bulge in the center and very distinct long arms that wind around the center. Our galaxy, the Milky Way, is a spiral galaxy.



Our solar system is in the Milky Way galaxy, which is a spiral galaxy with a bar across the center. The Milky Way's spiral arm where Earth is located is called the Orion Arm. We are about two-thirds of the way from the center to the edge of

Student Misconceptions
• Thinking that all galaxies have a uniform appearance (i.e. failing to recognize the diversity of shapes and structures among spiral, elliptical, and irregular galaxies) • Thinking that Earth is located at the center of the Milky Way galaxy • Thinking that the Milky Way galaxy is flat (as it is often depicted in textbooks and diagrams) • Thinking that galaxies are static and unchanging rather than dynamic and evolving over time • Thinking that galaxies are much closer together than they are, not accounting for the universe's immense scale. • Students may struggle comprehending the immense size and distance of galaxies as well as the vastness of space

the galaxy.

Possible STAAR Stimuli

Diagram	Visual/Image/ Illustration	Model
Informational Text/List*		

Standard:	7.9B describe how gravity governs motion within Earth's solar system

Specificity

Cognition: Describe
Content: describe how gravity governs motion within Earth's solar system
Including, but not limited to:

- Gravity – force of attraction between two objects due to their masses
  - Larger masses have a larger gravitational force than smaller masses.
  - Tendency to pull objects towards the center of the object with the larger mass
- Motion of our solar system
  - Revolution
  - Orbit
- Recognize gravitational attraction (force) between:
  - Sun and planets
  - Planets travel in a curved path (ellipse) instead of a straight line.
  - Planets and their moons
  - Sun and other objects in our solar system
  - Comets
  - Asteroids

Student Misconceptions

- Students may struggle with this content because this is the first time that gravity has been studied in the context of our solar system.
- Thinking that gravity exists only on Earth and is not a universal force
- Thinking that gravity has a constant strength throughout the solar system
- Thinking that gravity only pulls objects downward
- Thinking that all objects in space experience no gravity
- Thinking that gravity only affects planets and stars
- Thinking that the moon has no gravity
- Thinking that gravity is only responsible for causing motion
- Thinking that gravity is a result of an object's rotation
- Thinking that gravity is the only force in the universe

Instructional Implications

- Create opportunities for students to interact with varied solar system models and diagrams.
- Have students research and gather relevant information about the motion of celestial bodies within the solar system and describe their findings.

Content Builder

Gravity is a force of attraction between two or more masses. Gravity is the driving force behind the motion within Earth's solar system. It shapes the orbits of planets, moons, asteroids, and comets, ensuring their stability. The Sun, with its immense mass, serves as the primary gravitational anchor and exerts its influence on all objects within its realm. Gravity acts in all directions, not just downward.

Our solar system resides in the Milky Way galaxy and is made up of the Sun, eight planets, many moons, asteroids, meteoroids, and comets, all affected by gravity. All celestial bodies in the solar system move in predictable patterns known as orbits, which is controlled by gravity.

Every celestial body (including Earth) is surrounded by its own gravitational field, which exerts an attractive force on all objects nearby. The Sun's massive gravitational field attracts the entire solar system to orbit around it. Earth's gravitational field attracts the Moon into orbit around Earth and governs all motion on Earth. The Moon's gravitational field has attracted numerous meteorites that made impact craters, and its gravity even impacts Earth's oceans.

The scientific law concerning gravity is named Newton's universal law of gravitation because the law is true for all objects in our universe. Newton concluded that any two objects in the universe exert gravitational attraction on each other in a universal manner. He reasoned that every object in the universe attracts every other object with a force that is directly related to the mass of the objects and inversely related to the distance between the objects. This means the following:

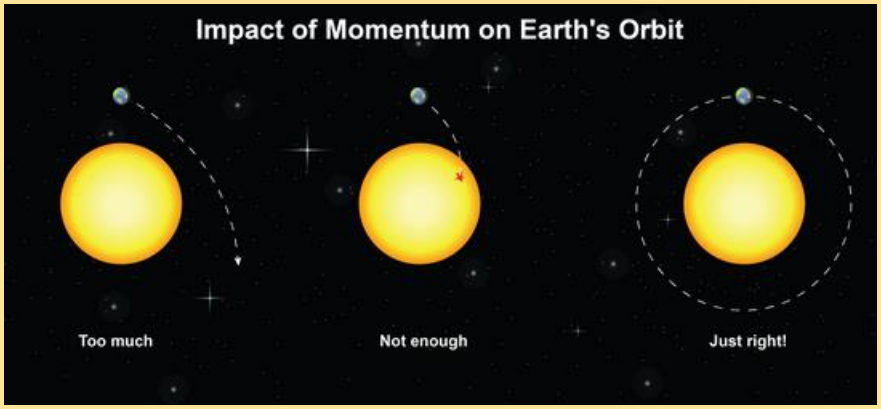
1. Gravity involves a direct relationship: the greater the mass of the objects, the greater the force of gravity, and the smaller the mass of the objects, the smaller the force of gravity.
2. Gravity also involves an inverse relationship: the greater the distance between the objects, the smaller the force of gravity, and the smaller the distance between the objects, the greater the force of gravity.

Everything that has mass has gravity. The more mass an object has, the stronger its gravitational pull on other objects. For example, Earth has more mass than the Moon, so its gravitational field is stronger. In addition, as the distance between two masses increases, the gravitational attraction between them decreases. So

- Teach students how to analyze their collected data and interpret it in the context of gravity's role in governing motion. Encourage them to create visual representations (graphs, charts, or diagrams) to illustrate their findings effectively.
- Explore mass vs. gravity and infer how gravity creates an unbalanced force. Provide opportunities for students to recognize the gravitational force between our Sun and moon, the planets, and the planets with moons.

Possible STAAR Stimuli

Investigation	Demonstration	Chart/Table
Diagram	Visual/Image/ Illustration	Informational Text/List



gravity depends directly on the mass of the objects and inversely on how far apart they are.

Earth's gravitational pull on us toward the center of Earth is strongest when standing on its surface compared to the effects of microgravity and out floating in a spacecraft thousands of miles away. The celestial body in our solar system with the most mass (and hence the strongest gravitational force) is the Sun. Because the Sun has the strongest gravitational field, it has the strongest influence on the motion of the other bodies in the solar system (i.e., planets). Be sure students understand that the same forces of gravity that affect our solar system also affect the rest of the universe. The massive pull of gravity also formed stars and galaxies, affecting their motion.

Celestial objects, such as planets, moons, asteroids, comets, meteors, and even satellites, move within the solar system around more massive objects along paths known as orbits. These orbital paths are determined by the momentum of these objects and the gravitational force exerted upon them from other, more massive objects. The laws of motion explain that an object's motion will continue unless acted on by an outside force (Newton's first law of motion). So, a moving object has momentum that carries it forward until forces slow it or stop it. For example, a thrown baseball has momentum that carries it forward until air friction slows it down, gravity pulls it downward, or someone catches it.

Earth's orbit around the Sun is determined by the balance of the Sun's gravitational pull on Earth and Earth's forward momentum as it travels around the Sun. Without the Sun's gravitational pull, Earth would not move in a circle around the Sun but would continue moving straight throughout the Milky Way. Without Earth's momentum, the Sun would pull Earth into itself. If an object does not have enough orbital speed or momentum to resist the pull of gravity, it will be pulled into the surface of the larger object. That is why meteorites crash into the surface of moons and planets. That is also why the Moon does not crash into Earth; it is orbiting at just the right speed and has just the right forward momentum to stay in orbit around Earth.

Standard:	6.9A model and illustrate how the tilted Earth revolves around the Sun, causing changes in seasons

Specificity

Cognition: Model, illustrate
Content: how the tilted Earth revolves around the Sun, causing changes in seasons
Including, but not limited to:

- Tilted Earth revolves around the Sun in a year (365 ¼ days).
  - This causes uneven lighting and heating of the Earth, with parts of the Earth receiving more direct light (energy) as compared to other parts.
  - Causes changes in seasons:
    - Hemisphere pointing towards the Sun experiences more intense heating of summer.
    - Hemisphere pointing away from the Sun experiences less intense heating of winter.
  - Causes seasons to have varying durations of daylight:
    - Poles point most towards and away from the Sun at different times of the year.
      - Winter gets shorter amounts of daylight.
      - Summer gets longer amounts of daylight.
      - Equator receives most consistent amount of daylight and nearly equal amounts of daylight and dark.

Student Misconceptions

- Thinking that the revolution of the Earth around the Sun is unrelated to the change of seasons
- Thinking that the amount of daylight/darkness a location receives is not directly related to the tilt of the rotating Earth as it revolves around the Sun
- Misaligning the Earth's axis by drawing it perpendicular to the plane of the orbit instead of tilted at about 23.5 degrees
- Incorrectly illustrating the Earth's orbit as a perfect circle instead of an ellipse
- Applying incorrect seasonal positioning or placing the Earth closer to the Sun during summer and farther during winter
- Incorrectly portraying the angle at which sunlight hits the Earth's surface, which is steeper in the winter and more direct in the summer for the hemisphere experiencing that season

Instructional Implications

The tilted Earth revolves around the Sun, causing changes in seasons. As the Earth orbits the Sun, different parts of the Earth receive varying amounts of sunlight, resulting in the four seasons: spring, summer, autumn, and winter.

Seasons are determined by the tilt of the Earth, not its distance from the Sun. Although the Sun emits a constant amount of energy, different places on Earth receive different amounts of solar energy. This is because of Earth's tilted axis, which is Earth's center of rotation. It takes Earth 24 hours to complete one spin, or rotation, on its axis.

As it rotates, different sides (or hemispheres) of Earth face the Sun. When one hemisphere faces the Sun, the other is in darkness. Earth's rotation is what creates daytime and nighttime. Although it seems Earth's axis would be perpendicular to the plane of its orbit, it is tilted. The axis tilts 23.5 degrees away from this plane and always faces the same direction, pointing toward the North Star (Polaris).

While Earth rotates on its axis, it also moves or revolves around the Sun on a path known as its orbit. This orbit is elliptical (not perfectly circular) in shape. The Sun does not sit directly in the center but slightly to one side of the ellipse. When Earth is closest to the Sun, it is 147 million km away, and at its farthest point, it is 152 million km away from the Sun.

Many believe that the distance to the Sun is what causes the seasons. In other words, when Earth is closest to the Sun, it is summer, and when it is farthest, it is winter. However, Earth is closest to the Sun in January and farthest away in July. The distance to the Sun does not cause the seasons; the tilt of Earth's axis causes them.

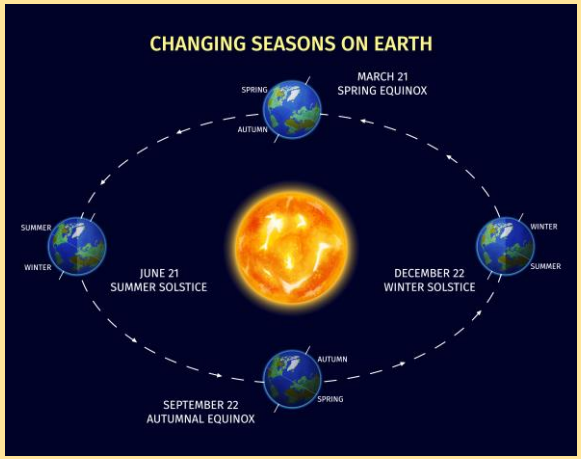
As Earth revolves around the Sun, its axis can be tilted toward or away from the Sun—depending on its location along its orbital path. Because of the tilt of Earth's axis and the fact that it always points in the same direction as it revolves, we have seasons.
The angle of the Sun's beams impacts the amount of energy a hemisphere receives. If sunlight strikes the surface at an angle, it will spread over a wider area

- Vary the models used to illustrate seasons. Use physical models, diagrams, videos, interactive simulations, or digital applications. Encourage students to compare and contrast the models to deepen their understanding of how the Earth's tilt impacts the occurrence of seasons and to use the models to illustrate their understanding.
- Create opportunities to explore the cyclic interactions of the system and predict effects at different locations on the globe. Provide scenarios or case studies that involve various latitudes or hemispheres.

Possible STAAR Stimuli

Investigation	Diagram	Visual/Image/ Illustration
Web/Cycle/Chain	Model	Informational Text/List

than if it hits the surface directly. Think of a flashlight. If you point a flashlight directly at the ground, a small but bright circle of light hits the ground. If you point the flashlight down at the ground at an angle, the light will spread out over a wider area and be less intense.



For example, when Earth's axis is tilted toward the Sun, the northern hemisphere receives more direct solar energy than the southern hemisphere. This is when the northern hemisphere has summer, and the southern hemisphere has winter. When Earth's axis is tilted away from the Sun, the northern hemisphere receives less direct energy from the Sun than the southern hemisphere, leading to the northern hemisphere's winter and southern hemisphere's summer. Fall and spring happen when neither hemisphere is tilted toward the Sun, and the Sun hits directly on the equator.

Standard:	6.9B describe and predict how the positions of the Earth, Sun, and Moon cause daily, spring, and neap cycles of ocean tides due to gravitational forces.

Specificity	**Content Builder**
Cognition: Describe, Predict Content: how the positions of the Earth, Sun, and Moon cause daily, spring, and neap cycles of ocean tides due to gravitational forces. Including, but not limited to: • Gravitational attraction ○ Force of attraction between all masses in the universe, especially the attraction of the Earth's mass for bodies near its surface • Tide	The lunar cycle is critical to understanding ocean tides. Tides happen when two bulges occur in Earth's oceans on opposite sides of Earth. First, the surface water on the side closest to the Moon forms a bulge because this is where the Moon's gravitational pull is greatest. Then, another bulge occurs on the opposite side of Earth because the Moon's gravitational force is weakest here, allowing the force from Earth's rotation on its axis (centrifugal force) to push water outward from the surface. Because water bulges in these two areas (high tides), the areas in between these bulges create depressions (low tides) to compensate.

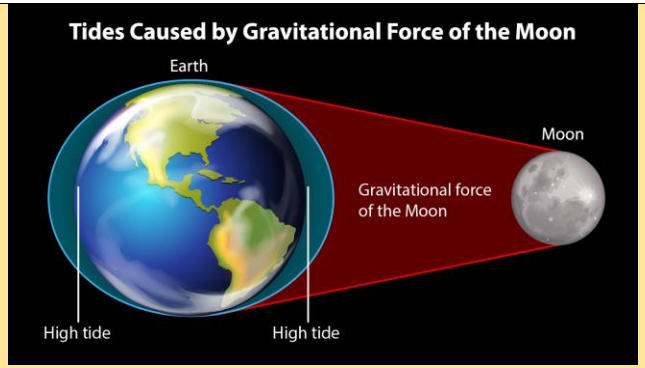
- The rising and falling of the oceans due to the gravitational attraction of the Moon and Sun; usually occurs twice each day
- Daily tides
  - Water on the side of the Earth closest to the Moon is most strongly affected by the Moon's gravitational pull.
  - Water bulges from the Earth towards the Moon.
  - Usually occurs twice each day
- Spring tide
  - Occurs at the full and new moon phases
  - Earth, Moon, and Sun are aligned in a straight line and pull the water in the same direction.
- Neap tide
  - Occurs at the first and third quarter phases
  - Sun and Moon are aligned at a right angle with the Earth as a vertex and pull water in perpendicular directions.

Instructional Implications

- Engage students in activities where they can analyze the positions of the Sun, Earth, and Moon and make predictions about the resulting tide levels. Help them understand how the gravitational forces exerted by the Moon and the Sun affect tidal patterns. Use charts, diagrams, or interactive tools to track the positions of celestial bodies and relate them to tidal changes.
- Use models and visual aids to illustrate the concept of ocean tides. Create physical models or use diagrams, animations, or simulations that represent the relationship between the positions of the Moon, the Sun, and the resulting high and low tides. Images can help students visualize the effects of gravitational forces on the Earth's oceans and understand the patterns of tidal fluctuations.
- Provide opportunities for students to describe and predict ocean tides, both verbally and in writing.
- Help students see the Recurring Theme and Concept of *patterns* in this standard.

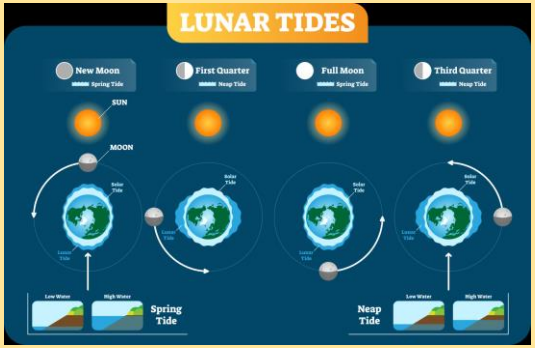
Student Misconceptions

- Thinking that tides are solely caused by the Moon's gravitational pull and overlooking the influence of the Sun's gravity on tidal patterns
- Thinking the term "spring tide" refers to the season of Spring rather than a specific tidal pattern with elevated tidal ranges



High tide is when sea level reaches its highest vertical level, which corresponds to the furthest it reaches inland. Low tide is when sea level reaches its lowest vertical point, which corresponds to the furthest out to sea the shoreline reaches. Tidal range is the difference in sea level between high and low tide.

The Sun's gravitational pull also affects on our ocean's tides. The Sun can work to either magnify or minimize the effect of the Moon on our tides. When Earth, the Sun, and Moon, are in a right-angle position, the Sun's gravitational pull interferes with the Moon's pull, and we experience less intense high and low tides. That is, high tide is not as high as usual, and low tide is not as low as usual. This tide, called neap tide, occurs during the first and last quarter moon phase. During neap tide, the tidal range is very small, in some instances only a few inches.



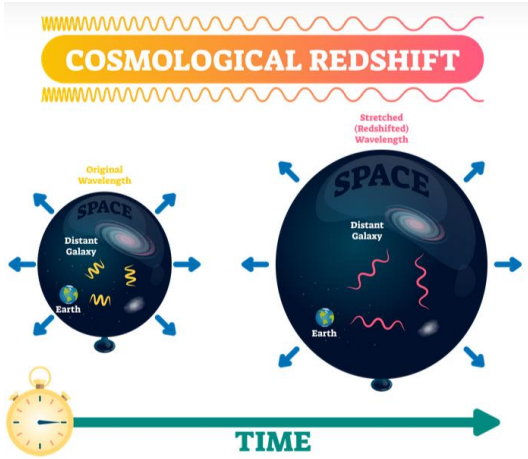
Conversely, when Earth, the Sun, and Moon are in a straight line, high tides are higher and low tides are lower than usual. This is because the Sun's gravitational pull adds to the Moon's gravitational pull. This tide, called spring tide, occurs during the new moon and full moon. The difference between high and low tide, or the tidal range, is greatest during spring tide.

Possible STAAR Stimuli

Demonstration	Diagram	Web/Cycle/Chain

• Thinking that gravitational forces directly pull the water upward, causing high tides, rather than creating a bulge in the water • Overlooking the role of the Earth's rotation in the daily tidal cycle that results in two high tides and two low tides each day • Confusing the concepts of spring and neap tides	Informational Text/List	Model

Standard:	8.9C Research and analyze scientific data used as evidence to develop scientific theories that describe the origin of the universe.

Specificity	**Content Builder**
Cognition: Research, Analyze Content: scientific data used as evidence to develop scientific theories that describe the origin of the universe Including, but not limited to: • Scientific data as evidence supporting theories ○ Origin of the universe ○ The Big Bang theory – the most widely supported and accepted theory of the origin of the universe ▪ Proposes that the universe was once condensed in a small, hot mass ▪ A huge explosion occurred which sent all matter and energy expanding in all directions. ➢ Supporting evidence ❖ Red-shift observations of galaxies moving away from each other and our own Milky Way galaxy □ Edwin Hubble ❖ Cosmic background radiation – microwave ❖ Elements – The chemical make-up of new stars is different than older stars. ❖ Looking back in time – Light takes a very long time to travel to Earth, so the observations we make of the light from distant objects in the universe are of the past. □ The steady state theory – states that the universe has not changed much over time ❖ Proposed that new stars are created at the same rate that old stars are destroyed ❖ Popular in the 1950's but new evidence in the 1960's made most scientists abandon the theory.	Scientists believe that the universe began ~14 billion years ago with the Big Bang. The big bang theory states that matter did not exist before the Big Bang occurred. The universe consisted of only energy, and all this energy was contained in an infinitely small area (smaller than an atom). Before the Big Bang, space and time were set to zero. After the Big Bang occurred, the four fundamental forces (gravity, electromagnetic force, strong nuclear force, and weak nuclear force) began to function, and the universe expanded rapidly. Two strong pieces of evidence support the big bang theory. The first piece of evidence is that the universe is still expanding. When scientists use telescopes to look at the night sky, they can see galaxies moving away from our galaxy at very high speeds. They can take pictures of these galaxies moving away from us using telescopes. Specifically, they want to measure the wavelengths of the light they see from these galaxies. Bodies moving away from us emit light that appears to have a lower-energy wavelength than what it actually is. This is called red shift. Knowing how much a celestial body's energy is red-shifted allows scientists to estimate the distance between the celestial body and us. Knowing the distance and the speed of light will enable scientists to estimate the age of that body and, eventually, the universe.  By measuring the distance between celestial bodies all over the galaxy, scientists can use this information to calculate how long ago all the galaxies were together

Instructional Implications

When you teach this concept, remember to:

- Introduce the historical development of cosmological theories from ancient ideas to modern understanding.
- Use visuals, simulations, and models to help students visualize complex cosmological concepts such as the big bang and cosmic inflation.
- Encourage critical thinking by discussing strengths and limitations of cosmological theories, prompting students to evaluate evidence and ask questions.
- Engage students with hands-on activities related to cosmology such as modeling universe expansion and simulating cosmic events.

Student Misconceptions

- Thinking that the universe has always existed in its current form and has no beginning or end
- Thinking that there is only one theory for the origin of the universe
- Thinking of the big bang as an explosion that occurred within pre-existing space rather than the expansion of space itself
- Thinking that the big bang was an event that happened in the past and not recognizing the expansion of the universe is an ongoing process
- Thinking that the big bang theory explains everything in the universe

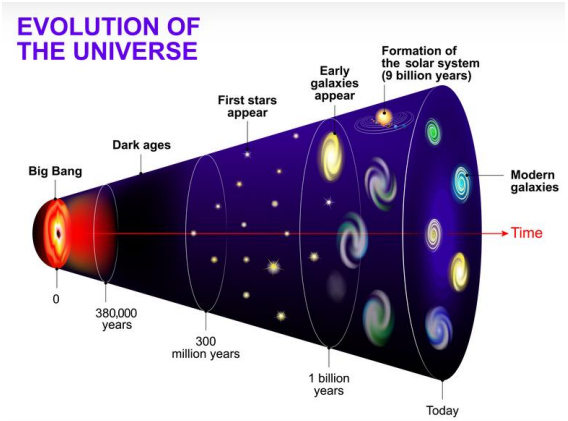
Possible STAAR Stimuli

Chart/Table	Visual/Image/ Illustration	Model
Informational Text/List		

at one point (in other words, the universe's age). Pictures of celestial bodies, particularly galaxies, can give information about their age and distance from the Milky Way galaxy; it can also tell us more about the galaxies' sizes, shapes, number of stars, and even number of planets.

The second piece of evidence that supports the big bang theory is that scientists can measure the background radiation of the universe by mapping microwave radiation. There is background radiation of 2.7 degrees above absolute zero (-273°C), which is believed to be the excess energy from the Big Bang.

Scientists also look for the oldest stars and other celestial bodies in the universe. By studying these bodies, understanding how long it took them to form, and knowing how old they are, scientists can create a boundary for the universe's age. In other words, if the oldest star is so many billion years old, then the universe is at least that old.



The origin of the universe is a long-debated topic. The big bang theory was first introduced 100 years ago and has been the most accepted theory for the origin of the universe for the past 50 years. However, there is still a lot to learn about how our universe began, and scientists are developing new theories and extensions to the original theory.

VERTICAL STANDARDS

This section details the **progression** of key student expectations/standards** in the courses **before** and **after** this course. This will help you understand what **prior knowledge skills to build upon** and guide you in knowing what **skills you are preparing your students** for in the subsequent course.

6th Grade	7th Grade	8th Grade

		8.9A Describe the life cycle of stars and compare and classify stars using the Hertzsprung-Russell diagram
		8.9B Categorize galaxies as spiral, elliptical, and irregular and locate Earth's solar system within the Milky Way galaxy
		8.9C Research and analyze scientific data used as evidence to develop scientific theories that describe the origin of the universe.

VOCABULARY GLOSSARY

Domain-specific words and definitions for this unit.

Key Content Vocabulary
List and define key vocabulary terms **Absolute Magnitude:** how bright the star appears at a standard distance of 32.6 light-years or 10 parasecs away from the observer. **Apparent Magnitude:** how bright a star looks or appears when viewed from Earth. **Absorption spectrum** - a spectrum that contains dark lines superimposed on a bright continuous spectrum. Also called a dark-line spectrum. (Lesson 03) **Black dwarf:** a dead star that no longer gives off any light or heat (Lesson 02) **Big bang theory:** a theory that says the universe began as a small point that expanded rapidly about 13.7 billion years ago (Lesson 8) **Black hole:** the remains of a star or other large object that collapsed under its own gravity to form a superdense object with gravity so strong that light cannot escape its pull (Lesson 02) **Cosmic Microwave Background:** electromagnetic radiation found all over the universe that is left over from its creation, is detected with a radio telescope, and is key evidence of the big bang theory of the origin of the universe (Lesson 08) **elliptical-shaped galaxy:** a galaxy with a long oval shape, a bright center, no apparent internal structure or spiral arms, and very little dust or gas (Lesson 06) **Emission spectrum** – a spectrum of colored lines on a dark background. Also called a bright line spectrum. In astronomy these are usually associated with nebulae. (Lesson 03) **galaxy:** a large grouping of stars, gases, and dust in space (Lesson 06) **Galactic center:** rotation center of a galaxy (Lesson 07) **Hertzsprung-Russell diagram:** a plot of the surface temperature (color) of stars vs. their luminosity (brightness) (Lessons 04 and 05)

Gravitational pull: ***t***he force of attraction that tends to draw together any two objects in the universe (Lesson 09)
irregular-shaped galaxy: a galaxy with very little symmetry that does not fit into any category (Lesson 06)
Luminosity: the intensity, or brightness, of light from a celestial body, which can be used to identify the body's characteristics (Lesson 04 and 05)
Main sequence: category of stable stars in the middle developmental phases that plot along a continuous diagonal belt on the Hertzsprung-Russell diagram (Lesson 02)
Magnitude: the sum of all the forces acting on an object (Lesson 09)
Milky Way Galaxy: the galaxy in which Earth and the Sun are located (Lesson 07)
neutron star: final stage of the life cycle for massive stars; formed after the star completely runs out of fuel and collapses every remaining proton in the core into a neutron (Lesson 02)
Nuclear fusion: the process by which two light atomic nuclei combine to form a single heavier one while releasing massive amounts of energy. (Lesson 02)
Orion Arm: the location of the Solar System in the Milky way galaxy. (Lesson 07)
planetary nebula: a cloud of interstellar gas and dust created by a dying, average-sized star (Lesson 02)
Protostar: a "baby" star and is the stage when a star gives off light and heat for the first time. (Lesson 02)
Red giant: a star with a larger diameter and lower surface temperature than an average star; formed when the fuel center of an average star is depleted (Lesson 02)
redshift: the change in wavelength that allows us to determine whether an object is moving toward us or away from us. (Lesson 08)
Red supergiant: a star with a larger diameter and lower surface temperature than a massive star; formed when the fuel center of a massive star is depleted (Lesson 02)
Spectrum – the band of colors produced when light is passed through a prism or similar device. (Lesson 03)
spiral-shaped galaxy: a galaxy with a bulge in the center and very distinct long arms winding around the center (Lesson 06)
Gravity – force of attraction between two objects due to their masses.
Inertia - the tendency of an object to resist a change in its state of motion until some force causes its speed or direction to change.
Orbit – the path that one object in space follows as it revolves around another object in space.
Orbital Velocity - the speed at which a celestial body revolves around the orbit of another celestial body.
Revolution – one complete orbit made by a planet or satellite around another object.
Descriptive Investigation- purpose is to determine relationships
Comparative Investigation - purpose is to draw conclusions
Experimental Investigation - purpose is to determine a causal relationship
Independent Variable: the variable the experimenter manipulates or changes and is assumed to have a direct effect on the *dependent variable.*
Dependent Variable: the variable being tested and measured in an experiment and is 'dependent' on the independent variable.
Constants: All factors that are held the same in order to create a "fair test" experiment. Also known as the controlled variables.
IVCDV Chart: Independent Variable, Constant, Dependent Variable chart. A graphic organizer to help you identify the parts of an investigation.
Control Group- a standard of comparison for checking or verifying the results of an experiment where all variables must be held constant; for experiments, a control (standard of comparison for checking or verifying the results of an experiment) is necessary
Experimental Group - the group(s) being tested with the independent variable; each experimental group has only one factor different from each other, everything else must remain constant
Season: a period of the year that is distinguished by special

climate conditions. The four seasons—spring, summer, fall, and winter—follow one another regularly. Each has its own light, temperature, and weather patterns that repeat yearly.
Axis: the line about which a rotating body, such as the Earth, turns
Latitude: lines that run North and South from the equator
Longitude: lines that run East and West
New Moon: *the moon's phase when it is in a horizontal line with the sun so that its dark side is toward the earth*
First Quarter Moon: occurs halfway between new moon and full moon. One quarter of the moon is visible from Earth, meaning that you see half the daylit side of the moon, looking like half a pie
Full Moon: the lunar phase when the Moon appears fully illuminated from Earth's perspective. This occurs when Earth is located between the Sun and the moon
Third Quarter Moon: AKA Last Quarter when the opposite half of the Moon is illuminated compared to the 1st Quarter. The left side illuminated. Last=left
As Earth rotates on its axis, the Moon exerts a gravitational pull-on Earth. Inertia acts as a counterbalance to the gravitational forces. Gravity and inertia are responsible for the creation of two ocean tidal bulges on opposite sides of Earth. This creates a predictable schedule of high tides and low tides that coincides with the lunar cycle.
Spring Tide: a tide just after a new or full moon, when there is the greatest difference between high and low water.
Neap Tide: a tide just after the first or third quarters of the moon when there is the least difference between high and low water.

Consumable Materials and Lab Supplies for Unit 4 (1 per group of 3-4 students unless noted)

Lesson	Commercial Vendor or Home	Lab Supplies (Science Vendor)
Lesson 01: Unit Introduction	None	
Lesson 02: Life Cycle of a Star	None	None
Lesson 03: Classifying Stars HR Diagram Part 1		Computer with Internet access
Lesson 04: Classifying Stars HR Diagram Part 2		Computer with Internet access
Lesson 05: Classifying Stars HR Diagram Part 3	Poster Board	
Lesson 06: Galaxies	None	
Lesson 07: The Milky Way		Teacher needs Tape and stopwatch
Lesson 08: Origin of the Universe	Tray Ball Balloon String	Ruler Felt Marker
Lesson 09: Gravity and Solar System Part 1		Computer with internet access for Phet Activity
Lesson 10: Gravity and Solar System Part 2	<u>Marbles in Motion (per group)</u> Transparent plastic cup Marble	<u>What's the Motion- teacher demo</u> Safety Goggles 1 plastic tube (an empty pen tube will work

	Markers or map pencils 1 foam ball 50 cm of string or yarn 1 large paperclip 5-10 metal washers (depending on the size) <u>What's the Motion- teacher demo</u> 1 foam ball 1 plastic tube (an empty pen tube will work 50 cm of string or yarn 1 large paperclip 5-10 metal washers (depending on the size)	
Lesson 11: Tilted Earth and Seasons Part 1 (Optional)	None	None
Lesson 12: Tilted Earth and Seasons Part 2	<u>Per group of students:</u> One Styrofoam ball Paper or Styrofoam plate One wooden skewer One wide rubber band Small snack or dixie up Small pen flashlight Protractor	<u>Teacher:</u> Scissors Marker Glue Cut out of a STAR to model Polaris
Lesson 13: Tilted Earth and Seasons Part 3	Same as above	
Lesson 14: Phases of the Moon		computer with internet access for use of Explore Learning Gizmo.
Lesson 15: Tides Part 1	For Tidal Model each student will need: • ½ Sheet of back paper • brad	• glue scissors
Lesson 16: Tides Part 2	None	