

Grade 5 Science

Unit 5: Astronomy: Space Systems

15 lessons and a unit quiz. Use this pack with the **Astronomy: Space Systems Student Reader** (print it, or download it once from the course) to teach the whole unit without the internet.

What is in this pack

- A lesson plan for each chapter: the Big Question, words to know, which pages to read, questions to talk over and the activity pages.
- The unit quiz, ready to print.
- Answers for the teacher at the back: every discussion question and the quiz key.

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Lesson schedule

Two or three lessons a week, about 30 minutes each. Tick each one off as you go.

	Lesson	Reader pages	Activity pages
☐	Lesson 1: Exploring Space	—	AP 1.1, AP 1.2
☐	Lesson 2: The Solar System	PDF pages 7–12	AP 2.1
☐	Lesson 3: The Vastness of Space	PDF pages 13–20	AP 3.1
☐	Lesson 4: Modeling Earth’s Revolution and Rotation	—	AP 4.1
☐	Lesson 5: Earth’s Movement	PDF pages 21–24	AP 5.1
☐	Lesson 6: Modeling the Sun-Earth-Moon Relationship	—	AP 6.1
☐	Lesson 7: The Moon from Earth	PDF pages 25–28	AP 7.1
☐	Lesson 8: Changing Star Patterns	—	AP 8.1
☐	Lesson 9: Brightness and Distance	—	AP 9.1
☐	Lesson 10: Brightness of Stars	PDF pages 29–32	AP 10.1
☐	Lesson 11: Constellations	PDF pages 33–36	AP 11.1
☐	Lesson 12: Diagramming Seasonal Constellations	—	AP 12.1
☐	Lesson 13: Gravity	PDF pages 37–42	AP 13.1, AP 13.2
☐	Lesson 14: Using Evidence About Gravity	—	AP 14.1, AP 14.2
☐	Lesson 15: Women and Studying Space	PDF pages 43–48	—
☐	Unit review and assessment	—	AP UR.1, AP UR.2
☐	Words quiz	—	—

Page numbers are the PDF page numbers of the Student Reader file, so they match what your PDF reader shows.

Lesson 1: Exploring Space

THE BIG QUESTION

How do people know what is in space?

Words to know

- **solar system** — a system of objects in space that includes at least one star, planets, their moons, asteroids, comets, and other space debris
- **galaxy** — a collection of stars, their solar systems, dust, and gas
- **universe** — all of the existing matter and energy in space
- **star** — a space object that gives off its own heat and light

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 24-30: the steps, materials and timing for this lesson.

Talk it over

1. What is outer space?
2. What are some of the things that exist in space?
3. How do scientists organize space from the largest system to the smallest?
4. What are some of the technological advancements that have helped us learn more about space?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How do people know what is in space?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 1.1: Exploring Space — Teacher Guide PDF pages 119-120
- Activity Page 1.2: Space Collage — Teacher Guide PDF page 121

Lesson 2: The Solar System

THE BIG QUESTION

What is the solar system?

Words to know

- **orbit** — the oval-shaped path an object follows as it revolves around another object in space (v. to revolve around another object)
- **solar system** — a system of objects in space that includes at least one star, planets, their moons, asteroids, comets, and other space debris
- **ellipse** — an oval shape
- **elliptical** — in the shape of an ellipse
- **planet** — a celestial body moving in an elliptical orbit around a star
- **revolution** — a single trip around another object
- **revolve** — to travel around
- **system** — parts taken together in a process
- **terrestrial** — related to solid earth

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 31–37: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 1: “The Solar System”: PDF pages 7–12. Look at the pictures and maps together.

Talk it over

1. What is the solar system?
2. What are some components of a solar system?
3. How are the planets similar?
4. How are they different?
5. How does each planet's distance from the sun affect its revolution around the sun?
6. to think back on past learning. What is the inside of Earth like?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What is the solar system?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 2.1: Objects in the Solar System — Teacher Guide PDF pages 122–123

Lesson 3: The Vastness of Space

THE BIG QUESTION

What is the universe, and what are galaxies?

Words to know

- **galaxy** — a collection of stars, their solar systems, dust, and gas
- **universe** — all of the existing matter and energy in space
- **crew** — an individual or team of people working to complete a mission
- **crewed** — describing a space mission that carries people aboard spacecraft
- **probe** — a spacecraft sent to gather data about a space object
- **rover** — an uncrewed probe that is launched from Earth, lands on another object in space, and travels around on that body's surface to gather data
- **satellite** — an object that orbits another object
- **space station** — a spacecraft in long-term orbit that is inhabited by a crew
- **system** — parts taken together in a process
- **telescope** — a device for detection and magnification of faraway objects
- **uncrewed** — without human occupants

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 38-44: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 2: "The Vastness of Space": PDF pages 13-20. Look at the pictures and maps together.

Talk it over

1. What is a solar system?
2. Why might the Milky Way galaxy be named the way it is?
3. How is the universe different from a solar system and a galaxy?
4. What do you see in the image on the page?
5. What did Alan Shepard do?
6. What did John Glenn do?
7. What did Buzz Aldrin and Neil Armstrong do?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What is the universe, and what are galaxies?

- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 3.1: The Universe — Teacher Guide PDF page 124

Lesson 4: Modeling Earth's Revolution and Rotation

THE BIG QUESTION

How can I model the ways that Earth moves in space?

Words to know

- **orbit** — the oval-shaped path an object follows as it revolves around another object in space (v. to revolve around another object)
- **axis** — an imaginary line through the center of an object that is a fixed point of reference
- **revolution** — a single trip around another object
- **revolve** — to travel around
- **rotate** — to spin around a fixed point

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 46–50: the steps, materials and timing for this lesson.

Talk it over

1. What evidence do you have that Earth is moving?
2. How can we make models to show how Earth moves?
3. Why is modeling important?
4. What are the shortcomings of a model?
5. In the model that you just acted out, if you represent Earth, what did your chair represent?
6. If your chair represents Earth, what could you represent?
7. How many times does Earth rotate in one year?
8. How many times does Earth revolve in one year?
9. What time of day could it be where the mark is located?
10. How does rotation affect the amount of sunlight a place receives?
11. What do opposite sides of the ball experience?
12. How did the shadow change throughout the day?
13. What causes the shadow of the stick to change?
14. On a planet that takes longer to rotate, would the shadow of the stick be affected?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can I model the ways that Earth moves in space?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 4.1: The Movement of Earth — Teacher Guide PDF pages 125–126

Lesson 5: Earth's Movement

THE BIG QUESTION

How does Earth move in space?

Words to know

- **axis** — an imaginary line through the center of an object that is a fixed point of reference
- **constellation** — a group of stars that forms a recognizable pattern in the sky
- **ellipse** — an oval shape
- **elliptical** — in the shape of an ellipse
- **rotate** — to spin around a fixed point
- **sphere** — a ball shape
- **spherical** — in the shape of a sphere

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 51-57: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 3: "Earth's Movement": PDF pages 21-24. Look at the pictures and maps together.

Talk it over

1. What is the difference between rotation and revolution?
2. What revolves around the Earth?
3. What revolves around the sun?
4. What is an orbit?
5. Why don't we feel Earth moving?
6. What evidence is there to support the idea that Earth is moving?
7. What happens to the sun when it sets?
8. Where is the axis of this ride?
9. How do you know that the ride has rotated?
10. Where is the axis on this type of ride?
11. How do you know that this ride has made a rotation?
12. What causes shadows to change?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How does Earth move in space?

- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 5.1: Patterns and Evidence of Movement — Teacher Guide PDF page 127

Lesson 6: Modeling the Sun-Earth-Moon Relationship

THE BIG QUESTION

How can I model the relationship among the sun, Earth, and the moon?

Words to know

- **lunar eclipse** — an event during which the moon passes directly behind Earth and into its shadow
- **solar eclipse** — an event during which the moon's shadow blocks all or some of the sun's light from reaching Earth
- **shadow** — a darkened area behind an object that blocks light

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 58–63: the steps, materials and timing for this lesson.

Talk it over

1. What is needed to make a shadow?
2. How does your shadow change throughout the day?
3. Is there any time during a sunny day that you cannot see your shadow at all?
4. Has anyone ever seen a lunar or solar eclipse?
5. What does eclipse mean?
6. What is the difference between a total eclipse and a partial eclipse?
7. How does the sun appear during a solar eclipse?
8. What time of day must a solar eclipse happen?
9. What can you expect to happen during a solar eclipse?
10. What causes the shadow during a lunar eclipse?
11. How are a lunar and solar eclipse alike?
12. How are a lunar and solar eclipse different?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can I model the relationship among the sun, Earth, and the moon?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 6.1: Shadows — Teacher Guide PDF page 128

Lesson 7: The Moon from Earth

THE BIG QUESTION

What are moon phases and eclipses?

Words to know

- **moon phase** — a stage in the repeating, predictable pattern of change in the moon's appearance from Earth
- **lunar eclipse** — an event during which the moon passes directly behind Earth and into its shadow
- **solar eclipse** — an event during which the moon's shadow blocks all or some of the sun's light from reaching Earth
- **reflect** — to bounce off of
- **shadow** — a darkened area behind an object that blocks light

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 64–70: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 4: “The Moon from Earth”: PDF pages 25–28. Look at the pictures and maps together.

Talk it over

1. How does the moon look each day or night?
2. What causes the moon to shine?
3. Is there ever a time when you cannot see the moon at all?
4. Which of these three objects—the sun, Earth, and the moon—creates light?
5. Why can we only ever see one side of the moon?
6. Can you see the light in the mirror?
7. Is the light coming from the mirror?
8. What happens to the light when you put your hand in front of the mirror?
9. What is needed for a shadow to exist?
10. When you hold your hand in front of the light, what shape can you expect the shadow to be?
11. How do shadows change during the day?
12. What causes shadows on the moon?
13. How can scientists predict eclipses?
14. What do the flashlight, the small ball, and the large ball represent?

15. How does the amount of light on the small ball change as it moves around the large ball?
16. What does this represent?
17. How long does it take this pattern of shadows to occur?
18. What is the difference between a lunar and solar eclipse?
19. How are the phases of the moon different from an eclipse?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What are moon phases and eclipses?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 7.1: Phases — Teacher Guide PDF page 129

Lesson 8: Changing Star Patterns

THE BIG QUESTION

How do star patterns provide evidence of Earth's movement?

Words to know

- **orbit** — the oval-shaped path an object follows as it revolves around another object in space (v. to revolve around another object)
- **galaxy** — a collection of stars, their solar systems, dust, and gas
- **constellation** — a group of stars that forms a recognizable pattern in the sky
- **pattern** — a recognizable or recurring design or sequence of events

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 71-74: the steps, materials and timing for this lesson.

Talk it over

1. What happens when you take a photo of something moving?
2. What is making the streaks of light across the sky?
3. What causes the streaks of light?
4. What are the streaks evidence of?
5. Did everyone draw Pollux in the exact same location?
6. How did you know where to draw Pollux?
7. What causes the pattern of movement in the star Pollux?
8. Pollux is part of a larger pattern of stars called a constellation. What can you predict about the movement of the other stars in the pattern?
9. Will Pollux ever disappear from view in Earth's night sky?
10. What pattern (constellation) is Pollux part of?
11. What galaxy in the universe is Pollux in?
12. Why can't you see Pollux during a sunny day?
13. Why is Pollux in different locations in Earth's night sky at different times of the year?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How do star patterns provide evidence of Earth's movement?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 8.1: Moving Stars — Teacher Guide PDF pages 130-131

Lesson 9: Brightness and Distance

THE BIG QUESTION

What is apparent brightness?

Words to know

- **absolute brightness** — how bright a star is from a standard distance of 32.6 light-years
- **apparent brightness** — how bright a star appears compared with other stars when all are viewed from Earth
- **light-year** — the distance that light travels in one Earth year

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 76–80: the steps, materials and timing for this lesson.

Talk it over

1. What do you notice about the stars in the photo?
2. Why are some of the stars brighter than other stars in the photo?
3. Which star is the brightest star to us on Earth?
4. Why does the sun have a large apparent brightness?
5. Why is it important to turn both flashlights on at the same time and keep them both on for the whole activity?
6. What does the flashlight represent?
7. What does the wall represent?
8. Is distance the only factor in a star's apparent brightness?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What is apparent brightness?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 9.1: Star Light, Star Bright — Teacher Guide PDF page 132

Lesson 10: Brightness of Stars

THE BIG QUESTION

Why do some stars appear brighter than others?

Words to know

- **star** — a space object that gives off its own heat and light
- **absolute brightness** — how bright a star is from a standard distance of 32.6 light-years
- **apparent brightness** — how bright a star appears compared with other stars when all are viewed from Earth
- **light-year** — the distance that light travels in one Earth year
- **cycle** — a series of steps, often in a repeating pattern

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 81–86: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 5: “Brightness of Stars”: PDF pages 29–32. Look at the pictures and maps together.

Talk it over

1. What star is closest to Earth?
2. What star is the brightest in the sky?
3. What tools do scientists use to study the stars?
4. What causes the stars to change position in the sky?
5. What do you think it means if one star is brighter than other stars?
6. What is a star made of?
7. Why are stars so hot?
8. Do stars move the way planets do?
9. What are some ways that stars differ?
10. Why can we only see the stars at night?
11. What is a life cycle?
12. How do life cycles differ between living things?
13. Do you think that a nonliving thing can have a life cycle?
14. Where is a star “born”?
15. What can affect a star's life cycle?

16. Which flashlight seemed brighter even though the flashlights were exactly the same?
17. Then why is it so bright to us?
18. What does the horizontal axis indicate?
19. What does the vertical axis indicate?
20. Where do most of the stars fall on the diagram?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: Why do some stars appear brighter than others?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 10.1: Comparing Stars — Teacher Guide PDF page 133

Lesson 11: Constellations

THE BIG QUESTION

What are constellations?

Words to know

- **constellation** — a group of stars that forms a recognizable pattern in the sky
- **Polaris** — the North Star
- **circumpolar** — describing something that revolves around one of Earth's poles
- **pole** — the center point (one each at Earth's Northern and Southern Hemispheres) through which its axis passes
- **sphere** — a ball shape
- **spherical** — in the shape of a sphere

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 87–91: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 6: “Constellations”: PDF pages 33–36. Look at the pictures and maps together.

Talk it over

1. Why do you need to know what time of year it is to navigate using the stars?
2. Can you name any constellations or patterns of stars that you have seen?
3. How do you think that the constellations such as Big Bear, Southern Cross, and Big Dipper got their names?
4. How are constellations named?
5. Why do different constellations contain different numbers of stars?
6. What affects the constellations that can be seen at any season?
7. Why are circumpolar stars best for navigation?
8. Why can circumpolar stars be seen year-round?
9. Which constellations can be seen right now?
10. How long will fully visible constellations be able to be seen in the sky?
11. Are there any constellations on the planisphere that can be seen year-round? Why?
12. Why does the planisphere have the small window in it?
13. Where do the other constellations go when they cannot be viewed from the window?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What are constellations?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 11.1: Patterns in the Constellations — Teacher Guide PDF pages 134–136

Lesson 12: Diagramming Seasonal Constellations

THE BIG QUESTION

Why does the night sky change throughout the seasons?

Words to know

- **constellation** — a group of stars that forms a recognizable pattern in the sky
- **seasonal** — relating to Earth's changing seasons

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 92–96: the steps, materials and timing for this lesson.

Talk it over

1. How do we know that Earth is moving in space?
2. What kind of evidence can we gather here on Earth to support the idea that Earth is moving in space?
3. What are some ways that Earth changes with the different seasons?
4. How do stars change with the seasons?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: Why does the night sky change throughout the seasons?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 12.1: Constellations — Teacher Guide PDF pages 137–138

Lesson 13: Gravity

THE BIG QUESTION

What is gravity?

Words to know

- **gravity** — a force that pulls objects toward each other
- **gravitational** — related to the force of gravity
- **revolve** — to travel around
- **sphere** — a ball shape
- **spherical** — in the shape of a sphere
- **tide** — a fluctuation in the water level at a shoreline

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 98–104: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 7: “Gravity”: PDF pages 37–42. Look at the pictures and maps together.

Talk it over

1. In what direction did the ball move when the string was attached to me?
2. In what direction did the ball move when the string was released?
3. What phenomenon in the natural world could this be a model for?
4. What might the string represent?
5. In what direction is the ball moving?
6. How will the ball's motion eventually change?
7. What if the girl had held the ball straight over her head and then let go? How would it move then?
8. How do you know these things?
9. What makes this hard to do?
10. How is the direction of these three forces similar and different?
11. Why does it help to have several images?
12. Which has more mass, you or Earth?
13. Which of these objects (you, the moon, Earth) have gravitational force?
14. What did the string represent in this model?
15. What would happen to the moon if Earth had no gravity?

16. Why does the force of gravity seem to make a bigger change to the ocean than to the land?
17. What are the types of solar system objects you learned about earlier in this unit?
18. Which of these objects' motions are affected by gravity? How do you know?
19. Which object has the greatest force of gravity of all of these, and why?
20. How could we use this model to show what keeps planets in their orbits?
21. What other objects in the solar system can the ball on the string represent?
22. From what you know of the model, what would happen to all these objects if the sun's gravity ceased to exist?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What is gravity?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 13.1: Diagramming the Direction of Earth's Gravitational Pull — Teacher Guide PDF page 139
- Activity Page 13.2: Check — Teacher Guide PDF page 140

Lesson 14: Using Evidence About Gravity

THE BIG QUESTION

How can I use evidence to support an argument that Earth is a sphere?

Words to know

- **gravity** — a force that pulls objects toward each other
- **sphere** — a ball shape

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 105–111: the steps, materials and timing for this lesson.

Talk it over

1. How does this model represent what “down” means on Earth?
2. How do you know gravity exists on Earth?
3. How do we depend on gravity?
4. What evidence is there that gravity is a force in the solar system?
5. What are the names of some three-dimensional shapes?
6. Which of these shapes best describes planet Earth?
7. What other familiar objects are shaped like a sphere?
8. What are the attributes of a sphere?
9. What is the common shape of all the planets in the solar system?
10. What might gravity have to do with the shape of planets and moons?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can I use evidence to support an argument that Earth is a sphere?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 14.1: Earth's Shape Evaluation Guide — Teacher Guide PDF page 141
- Activity Page 14.2: Identifying Evidence of Earth's Shape — Teacher Guide PDF pages 142–143

Lesson 15: Women and Studying Space

THE BIG QUESTION

How have people learned about space systems?

Words to know

- **orbit** — the oval-shaped path an object follows as it revolves around another object in space (v. to revolve around another object)
- **solar system** — a system of objects in space that includes at least one star, planets, their moons, asteroids, comets, and other space debris
- **galaxy** — a collection of stars, their solar systems, dust, and gas
- **universe** — all of the existing matter and energy in space
- **axis** — an imaginary line through the center of an object that is a fixed point of reference
- **moon phase** — a stage in the repeating, predictable pattern of change in the moon's appearance from Earth
- **lunar eclipse** — an event during which the moon passes directly behind Earth and into its shadow
- **solar eclipse** — an event during which the moon's shadow blocks all or some of the sun's light from reaching Earth
- **star** — a space object that gives off its own heat and light
- **absolute brightness** — how bright a star is from a standard distance of 32.6 light-years
- **apparent brightness** — how bright a star appears compared with other stars when all are viewed from Earth
- **light-year** — the distance that light travels in one Earth year
- **constellation** — a group of stars that forms a recognizable pattern in the sky
- **gravity** — a force that pulls objects toward each other

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 112–116: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 8: "Women and Studying Space": PDF pages 43–48. Look at the pictures and maps together.

Talk it over

1. What parts of the universe did you learn about?
2. How do people know what we know about the universe?

3. How does Earth's movement affect life on Earth?
4. How does Earth's movement affect our view of the night sky?
5. What affects how bright a star appears?
6. What does gravity have to do with astronomy?
7. How did Nancy Grace Roman and Katherine Johnson contribute to our understanding of space?
8. What role do scientists, engineers, and mathematicians play in space missions?
9. What types of jobs might be involved with learning about stars and their distances from Earth?
10. What types of jobs might be involved with learning about seasonal changes and the movement of Earth?
11. What types of jobs might be involved in learning more about gravity?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How have people learned about space systems?
- Use one of today's words in a sentence of your own.

UNIT REVIEW

Unit review and assessment

- Unit Assessment (print for your student): Teacher Guide PDF pages 146–151
- How to mark it (for the teacher): Teacher Guide PDF pages 155–156
- Activity page answer key (for the teacher): Teacher Guide PDF pages 152–154
- Activity Page UR.1: Space Systems Big Questions — Teacher Guide PDF page 144
- Activity Page UR.2: Vocabulary Review — Teacher Guide PDF page 145

WORDS QUIZ

Astronomy: Space Systems

Name: _____ Date: _____

Circle the letter of the best answer.

1. Which word means “a collection of stars, their solar systems, dust, and gas”?
 - a) galaxy
 - b) constellation
 - c) star
 - d) absolute brightness
2. Which word means “an event during which the moon’s shadow blocks all or some of the sun’s light from reaching Earth”?
 - a) solar system
 - b) lunar eclipse
 - c) solar eclipse
 - d) light-year
3. Which word means “a system of objects in space that includes at least one star, planets, their moons, asteroids, comets, and other space debris”?
 - a) solar eclipse
 - b) axis
 - c) universe
 - d) solar system
4. Which word means “a force that pulls objects toward each other”?
 - a) gravity
 - b) orbit
 - c) solar system
 - d) galaxy
5. Which word means “how bright a star appears compared with other stars when all are viewed from Earth”?
 - a) moon phase
 - b) apparent brightness
 - c) light-year
 - d) orbit
6. Which word means “a space object that gives off its own heat and light”?
 - a) moon phase
 - b) star
 - c) solar eclipse
 - d) gravity

7. Which word means “an imaginary line through the center of an object that is a fixed point of reference”?

- a) galaxy
- b) gravity
- c) apparent brightness
- d) axis

8. Which word means “an event during which the moon passes directly behind Earth and into its shadow”?

- a) absolute brightness
- b) moon phase
- c) lunar eclipse
- d) universe

9. Which word means “a stage in the repeating, predictable pattern of change in the moon’s appearance from Earth”?

- a) constellation
- b) moon phase
- c) lunar eclipse
- d) apparent brightness

10. Which word means “a group of stars that forms a recognizable pattern in the sky”?

- a) light-year
- b) apparent brightness
- c) constellation
- d) moon phase

11. Which word means “all of the existing matter and energy in space”?

- a) universe
- b) light-year
- c) star
- d) moon phase

12. Which word means “the oval-shaped path an object follows as it revolves around another object in space (v. to revolve around another object)”?

- a) orbit
- b) moon phase
- c) galaxy
- d) universe

Answers

Lesson 1: Exploring Space

1. **What is outer space?**
The universe beyond Earth's atmosphere
2. **What are some of the things that exist in space?**
Planets, stars, galaxies, moons, comets
3. **How do scientists organize space from the largest system to the smallest?**
The universe, galaxies, solar systems
4. **What are some of the technological advancements that have helped us learn more about space?**
Telescopes, space probes, rovers, a space station, lunar landing, etc.

Lesson 2: The Solar System

1. **What is the solar system?**
A system of objects in space that includes at least one star, planets, their moons, asteroids, comets, and other space debris
2. **What are some components of a solar system?**
One to three stars, planets, moons, asteroids, comets, meteors, etc.
3. **How are the planets similar?**
Both are rocky; both are hotter than Earth.
4. **How are they different?**
One is very small; one is much larger.
5. **How does each planet's distance from the sun affect its revolution around the sun?**
Because Mercury is closer, its revolution distance is shorter.
6. **to think back on past learning. What is the inside of Earth like?**
Parts of it are hard rock, but deeper beneath the surface, the greater pressures transform it into molten rock.

Lesson 3: The Vastness of Space

1. **What is a solar system?**
A system of objects in space that include at least one star, planets, their moons, asteroids, comets, and other space debris
2. **Why might the Milky Way galaxy be named the way it is?**
To ancient peoples, it looked like a milky road in the sky.
3. **How is the universe different from a solar system and a galaxy?**
There are many solar systems in a galaxy. There are many galaxies in the universe.
4. **What do you see in the image on the page?**
Most will say that they see stars. Point out that these are not all stars. Many of them are galaxies, with the light of all the stars in those galaxies combined. Others are the

light of more than one galaxy combined.

5. **What did Alan Shepard do?**

He was the first American to travel into space.

6. **What did John Glenn do?**

He was the first American to completely orbit Earth.

7. **What did Buzz Aldrin and Neil Armstrong do?**

They were the first humans to walk on the moon.

Lesson 4: Modeling Earth's Revolution and Rotation

1. **What evidence do you have that Earth is moving?**

Shadows changing, stars changing, moon changing, day turning into night

2. **How can we make models to show how Earth moves?**

Act it out, use clay or foam models, make a computer animation, or draw a diagram with labels

3. **Why is modeling important?**

It helps scientists to look at something in more detail to determine patterns, gather data, or make predictions.

4. **What are the shortcomings of a model?**

They do not always react or work exactly the way that real-life objects do.

5. **In the model that you just acted out, if you represent Earth, what did your chair represent?**

The sun

6. **If your chair represents Earth, what could you represent?**

The moon

7. **How many times does Earth rotate in one year?**

365 times

8. **How many times does Earth revolve in one year?**

Only once

9. **What time of day could it be where the mark is located?**

Daytime

10. **How does rotation affect the amount of sunlight a place receives?**

As Earth rotates, each place on Earth will have daytime and nighttime.

11. **What do opposite sides of the ball experience?**

Opposite "times of day"

12. **How did the shadow change throughout the day?**

It got shorter or longer.

13. **What causes the shadow of the stick to change?**

The rotation of Earth

14. **On a planet that takes longer to rotate, would the shadow of the stick be affected?**

Yes, it would take longer to change.

Lesson 5: Earth's Movement

1. What is the difference between rotation and revolution?

One moves only around an axis, and one moves all the way around another object.

2. What revolves around the Earth?

The moon

3. What revolves around the sun?

Planets, Earth, comets

4. What is an orbit?

The path a body traces during one revolution

5. Why don't we feel Earth moving?

Because the planet is so large

6. What evidence is there to support the idea that Earth is moving?

The rising and setting sun, the length of shadows, changing seasons

7. What happens to the sun when it sets?

The sun does not move; it is still in the same place but shining on a different part of Earth.

8. Where is the axis of this ride?

In the center

9. How do you know that the ride has rotated?

Because you see the same things again that you saw where the motion started

10. Where is the axis on this type of ride?

In the center

11. How do you know that this ride has made a rotation?

You exit the ride in the same place where you boarded it.

12. What causes shadows to change?

The angle of light that results from Earth's changing position relative to the sun

Lesson 6: Modeling the Sun-Earth-Moon Relationship

1. What is needed to make a shadow?

Something coming in between light and a surface casts a shadow.

2. How does your shadow change throughout the day?

It grows shorter and longer.

3. Is there any time during a sunny day that you cannot see your shadow at all?

When the light is from straight overhead

4. Has anyone ever seen a lunar or solar eclipse?

Answers will vary.

5. What does eclipse mean?

When one object blocks another from view

6. **What is the difference between a total eclipse and a partial eclipse?**
In one, the moon or sun is completely covered, and in the other, only part of it is covered.
7. **How does the sun appear during a solar eclipse?**
The moon moves across the sun and blocks it out.
8. **What time of day must a solar eclipse happen?**
During daylight hours
9. **What can you expect to happen during a solar eclipse?**
It gets dark during the day, you can see stars, and night animals may wake up.
10. **What causes the shadow during a lunar eclipse?**
Earth blocks the sun's light from striking the moon.
11. **How are a lunar and solar eclipse alike?**
They both involve the sun, Earth, and the moon. They both occur when one object blocks light from the sun.
12. **How are a lunar and solar eclipse different?**
In a lunar eclipse, Earth comes between the moon and the sun. In a solar eclipse, the moon comes between Earth and the sun. A solar eclipse happens during the day and causes the sky to darken. A lunar eclipse happens at night.

Lesson 7: The Moon from Earth

1. **How does the moon look each day or night?**
It is of different shapes and also sometimes it is large and sometimes it is smaller.
2. **What causes the moon to shine?**
The moon shines because it reflects sunlight.
3. **Is there ever a time when you cannot see the moon at all?**
It could be covered by clouds or completely blocked by Earth's shadow.
4. **Which of these three objects—the sun, Earth, and the moon—creates light?**
The sun
5. **Why can we only ever see one side of the moon?**
Because the moon rotates with the same period as it revolves around Earth, only one side of the moon is visible.
6. **Can you see the light in the mirror?**
Yes
7. **Is the light coming from the mirror?**
No, it is only reflected in the mirror.
8. **What happens to the light when you put your hand in front of the mirror?**
It blocks it.
9. **What is needed for a shadow to exist?**
A light and a solid object to block it
10. **When you hold your hand in front of the light, what shape can you expect the shadow to be?**

The shape of your hand

11. How do shadows change during the day?

They become longer and shorter.

12. What causes shadows on the moon?

Earth

13. How can scientists predict eclipses?

They can use computers and models and analyze patterns using math.

14. What do the flashlight, the small ball, and the large ball represent?

The sun, the moon, and Earth

15. How does the amount of light on the small ball change as it moves around the large ball?

It doesn't. The appearance from different angles makes smaller or larger portions of the constantly lit surface visible.

16. What does this represent?

The phases of the moon

17. How long does it take this pattern of shadows to occur?

About a month

18. What is the difference between a lunar and solar eclipse?

In a lunar eclipse, Earth casts a shadow on the moon so the moon becomes shadowed. In a solar eclipse, the moon casts a shadow on Earth, so Earth becomes shadowed. In both cases, the light from the sun is blocked and forms shadows.

19. How are the phases of the moon different from an eclipse?

In an eclipse, Earth comes between the sun and the moon and casts a shadow on the moon. The phases of the moon occur because various areas of the moon reflect sunlight at different times during the moon's orbit around Earth.

Lesson 8: Changing Star Patterns

1. What happens when you take a photo of something moving?

The image blurs.

2. What is making the streaks of light across the sky?

Stars

3. What causes the streaks of light?

The light from the stars as they appear to move across the sky

4. What are the streaks evidence of?

The rotation of Earth on its axis

5. Did everyone draw Pollux in the exact same location?

Close to it

6. How did you know where to draw Pollux?

By predicting the pattern

7. **What causes the pattern of movement in the star Pollux?**
The revolution of Earth around the sun
8. **Pollux is part of a larger pattern of stars called a constellation. What can you predict about the movement of the other stars in the pattern?**
They will move across the sky in the same pattern.
9. **Will Pollux ever disappear from view in Earth's night sky?**
It will appear to but will still be visible to a different part of Earth.
10. **What pattern (constellation) is Pollux part of?**
Gemini
11. **What galaxy in the universe is Pollux in?**
The Milky Way galaxy
12. **Why can't you see Pollux during a sunny day?**
In Earth's rotation on its axis, the sun's light is stronger than the light of the star.
13. **Why is Pollux in different locations in Earth's night sky at different times of the year?**
Because of Earth's changing position in its revolution as it orbits around the sun

Lesson 9: Brightness and Distance

1. **What do you notice about the stars in the photo?**
Some are brighter, and some are dimmer.
2. **Why are some of the stars brighter than other stars in the photo?**
It is a combination of the actual brightness [magnitude] of a star and how far it is from Earth.
3. **Which star is the brightest star to us on Earth?**
The sun
4. **Why does the sun have a large apparent brightness?**
Many stars are actually brighter, but the sun is so very close it has the greatest apparent brightness.
5. **Why is it important to turn both flashlights on at the same time and keep them both on for the whole activity?**
So that the variable is controlled and the batteries do not affect the observations or results of the activity
6. **What does the flashlight represent?**
A star
7. **What does the wall represent?**
Earth
8. **Is distance the only factor in a star's apparent brightness?**
No, both distance and absolute brightness must be considered.

Lesson 10: Brightness of Stars

1. **What star is closest to Earth?**
The sun

2. **What star is the brightest in the sky?**
The sun
3. **What tools do scientists use to study the stars?**
Telescopes, satellites, or probes
4. **What causes the stars to change position in the sky?**
Stars appear to move across the sky as the night goes by due to Earth's rotation.
Stars also change with the seasons because Earth is revolving around the sun.
5. **What do you think it means if one star is brighter than other stars?**
It could be closer to Earth or bigger than other stars. Or it could be, and is, a combination of the two.
6. **What is a star made of?**
Gases
7. **Why are stars so hot?**
The gas is undergoing nuclear reactions that release energy and heat.
8. **Do stars move the way planets do?**
Most do not revolve, but they do rotate.
9. **What are some ways that stars differ?**
Size, brightness, color, distance from Earth
10. **Why can we only see the stars at night?**
They are so far from us that we can only see them when it is dark; our sun is so bright compared to them.
11. **What is a life cycle?**
The pattern of growth and development an organism goes through in its lifetime
12. **How do life cycles differ between living things?**
Some are shorter or longer; some include different stages.
13. **Do you think that a nonliving thing can have a life cycle?**
Answers may vary.
14. **Where is a star "born"?**
In a cloud of gas and dust
15. **What can affect a star's life cycle?**
Its size [mass]
16. **Which flashlight seemed brighter even though the flashlights were exactly the same?**
The one that was closer to the wall
17. **Then why is it so bright to us?**
Because it is so close
18. **What does the horizontal axis indicate?**
Temperature of stars
19. **What does the vertical axis indicate?**
The brightness of stars compared to the sun

20. **Where do most of the stars fall on the diagram?**

In the main sequence

Lesson 11: Constellations

1. **Why do you need to know what time of year it is to navigate using the stars?**

At different times of the year, different stars are visible.

2. **Can you name any constellations or patterns of stars that you have seen?**

Big Dipper, Orion's Belt, etc.

3. **How do you think that the constellations such as Big Bear, Southern Cross, and Big Dipper got their names?**

People look for shapes in the stars, the same way that you can look at clouds and imagine shapes.

4. **How are constellations named?**

By the shape that people can see in the outline

5. **Why do different constellations contain different numbers of stars?**

There isn't a set number of stars required to form a made-up picture.

6. **What affects the constellations that can be seen at any season?**

How close the stars are to the poles, the time of year, and the time of night

7. **Why are circumpolar stars best for navigation?**

Because they can be seen in essentially the same position year-round

8. **Why can circumpolar stars be seen year-round?**

Because Earth's poles always point toward the same regions of space

9. **Which constellations can be seen right now?**

Answers will vary.

10. **How long will fully visible constellations be able to be seen in the sky?**

About two or three months

11. **Are there any constellations on the planisphere that can be seen year-round? Why?**

Answers will vary; because they are close to the poles.

12. **Why does the planisphere have the small window in it?**

This represents the view from Earth during that particular time of year.

13. **Where do the other constellations go when they cannot be viewed from the window?**

They are still there but not in our field of view from our location on Earth.

Lesson 12: Diagramming Seasonal Constellations

1. **How do we know that Earth is moving in space?**

Shadows change, seasons change, days grow longer and shorter, and the moon's appearance changes.

2. **What kind of evidence can we gather here on Earth to support the idea that Earth is moving in space?**

We can create models, we can measure the change in shadows, and we can make observations of the stars.

3. **What are some ways that Earth changes with the different seasons?**

The temperature and length of day changes, and animals and plants behave differently in different seasons.

4. **How do stars change with the seasons?**

Some stars can only be seen during certain times of year.

Lesson 13: Gravity

1. **In what direction did the ball move when the string was attached to me?**

In a circle

2. **In what direction did the ball move when the string was released?**

In a straight line

3. **What phenomenon in the natural world could this be a model for?**

Accept all plausible answers.

4. **What might the string represent?**

Accept all answers.

5. **In what direction is the ball moving?**

It could either be on its way up or on its way down.

6. **How will the ball's motion eventually change?**

Assuming it is on its way upward, it will stop moving up and start to move down.

7. **What if the girl had held the ball straight over her head and then let go? How would it move then?**

It would move straight down.

8. **How do you know these things?**

Possible answer: I have done this many times, and it always happens the same way.

9. **What makes this hard to do?**

The books are heavy and are being pulled down by the force of gravity.

10. **How is the direction of these three forces similar and different?**

Electric and magnetic forces both attract and repel, but gravity only pulls, or attracts.

11. **Why does it help to have several images?**

If you look at different parts of the sphere, you can see that it is round from every view. Only spheres appear this way.

12. **Which has more mass, you or Earth?**

Earth

13. **Which of these objects (you, the moon, Earth) have gravitational force?**

All of them

14. **What did the string represent in this model?**

The pull of Earth's gravity

15. **What would happen to the moon if Earth had no gravity?**
It would travel off in a straight line, like the ball did.
16. **Why does the force of gravity seem to make a bigger change to the ocean than to the land?**
Because liquid ocean water is easier to move than solid rock
17. **What are the types of solar system objects you learned about earlier in this unit?**
The sun; the rocky planets: Mercury, Venus, Earth, and Mars; the ice/gas giants: Jupiter, Saturn, Uranus, Neptune; other objects: dwarf planets, asteroids, meteoroids, and comets
18. **Which of these objects' motions are affected by gravity? How do you know?**
All of them, because they all have mass
19. **Which object has the greatest force of gravity of all of these, and why?**
The sun, because it has the greatest mass
20. **How could we use this model to show what keeps planets in their orbits?**
The person whirling the end of the string can represent the sun, and the ball can represent a planet.
21. **What other objects in the solar system can the ball on the string represent?**
The sun plus any planet, dwarf planet, asteroid, meteoroid, moon, or comet
22. **From what you know of the model, what would happen to all these objects if the sun's gravity ceased to exist?**
They would all fly off in straight lines.

Lesson 14: Using Evidence About Gravity

1. **How does this model represent what "down" means on Earth?**
No matter where on Earth you stand, Earth's force of gravity pulls you toward its center. That is what "down" means.
2. **How do you know gravity exists on Earth?**
Everything that has any mass falls down. Some force is pulling objects downward.
3. **How do we depend on gravity?**
We expect to sit, stand, and move around under the force of gravity, and we expect that buildings, furniture, and everything else will stay in place or fall to the ground.
4. **What evidence is there that gravity is a force in the solar system?**
Planets revolve around the sun, and moons revolve around planets.
5. **What are the names of some three-dimensional shapes?**
Cubes, cones, cylinders, and spheres
6. **Which of these shapes best describes planet Earth?**
A sphere
7. **What other familiar objects are shaped like a sphere?**
Marbles, basketballs, soccer balls, baseballs, world globes, soap bubbles, the moon,

the sun

8. **What are the attributes of a sphere?**

A sphere is a solid shape in which all points on its surface are an equal distance to the center point of the sphere. A sphere has only one surface and no edges or corners.

9. **What is the common shape of all the planets in the solar system?**

They are all spheres.

10. **What might gravity have to do with the shape of planets and moons?**

All objects pull toward a common center of gravity, which creates a sphere. A planet's gravity pulls equally from all sides.

Lesson 15: Women and Studying Space

1. **What parts of the universe did you learn about?**

Galaxies, solar systems, stars, planets, moons

2. **How do people know what we know about the universe?**

Technology, including telescopes and spacecrafts that collect data

3. **How does Earth's movement affect life on Earth?**

The calendar year is based on Earth's revolution around the sun. Day and night are based on Earth's rotation. The seasons are the result of Earth's movement.

4. **How does Earth's movement affect our view of the night sky?**

Depending on the movement of Earth in its revolution and rotation, some stars can be seen all year long, only at certain times of the year, or only in one hemisphere.

5. **What affects how bright a star appears?**

Distance, actual brightness

6. **What does gravity have to do with astronomy?**

Gravity is the force that results in the position and movement of stars, planets, moons, and all objects in the universe.

7. **How did Nancy Grace Roman and Katherine Johnson contribute to our understanding of space?**

Made discoveries, helped plan and develop the Hubble Space Telescope, oversaw operations, used mathematics to plan space missions

8. **What role do scientists, engineers, and mathematicians play in space missions?**

Scientists establish hypotheses to test. Engineers design spacecrafts. Mathematicians calculate distances and measurements to make sure missions are successful. Computer programmers create models of space.

9. **What types of jobs might be involved with learning about stars and their distances from Earth?**

For example, discovering stars and planets, measuring distances in space, building telescopes

10. **What types of jobs might be involved with learning about seasonal changes and the movement of Earth?**

For example, measuring temperature and climactic changes, using solar and wind power at different times of the year

11. **What types of jobs might be involved in learning more about gravity?**

For example, finding ways to use gravity as a power source, measuring gravitational pull in space, designing space travel in weightless environments

Unit quiz key

1. a 2. c 3. d 4. a 5. b 6. b 7. d 8. c 9. b 10. c 11. a 12. a