

Thinking About Earth as a Planet

Inquiries **1**
Periods **2**

STUDENT OBJECTIVES

Record their ideas and questions about Earth in space.

Record their responses to 10 common questions about space.

Analyze the class's responses to these 10 questions.

CONCEPTS

Earth is a planet in our solar system.

People's ideas about Earth as a planet have evolved through history.

Phenomena such as day and night, seasons, tides, and gravity can be explained within the context of Earth as a planet.

Student misconceptions about astronomy can be assessed through discussion.

OVERVIEW

This lesson serves as an assessment of students' current ideas about Earth in the solar system. Students begin by brainstorming what they know about Earth as a planet. They then record their answers to 10 questions that address their most common misconceptions about space.

Each group is assigned one question and asked to consolidate and report on the most common responses to that question. Students debate the consolidated responses. The lesson ends as students reflect on what they know about Earth in space and record questions they have about the solar system. Students are advised to revisit these responses and questions as needed throughout the module.

BACKGROUND

The *National Science Education Standards* (NSES) developed by the National Research Council (NRC) and the *Benchmarks for Science Literacy* developed by the American Association for the Advancement of Science (AAAS)—as well as other standards—provide a framework for exploring astronomy at the K–12 level. For example, according to the standards set by the NRC, students in grades K–4 learn about the objects and motions in the sky from a **geocentric** (Earth-centered) perspective. Students in grades 5–8 learn about the motions of the objects in the solar system from a **heliocentric** (Sun-centered) perspective. Students in grades 9–12 move beyond understanding the solar system and learn about stellar evolution and the structure of the Universe.

Using the heliocentric perspective, students in grades 5–8 can explain the phenomena of day and night, seasons, eclipses, and lunar phases as

a result of planetary motion and size relationships. Students at this age compare and contrast solar system objects on the basis of their composition (that is, terrestrial versus gaseous), satellite systems (number of moons), rotation and revolution, size and mass, and temperature, among other characteristics. Students should have an accurate understanding of a spherical Earth where gravity acts to hold people to Earth's surface. In addition, students should understand through modeling that planets orbit the Sun in almost perfect circles because of the Sun's gravitational pull.

It is important to allow students to consider first what they already know about astronomy. This process helps you understand students' preconceptions, develop appropriate learning experiences for students, and develop appropriate assessments that measure growth in students' knowledge and understanding.

To best assess students' preconceptions in this lesson, it is important to do the following:

- Individually assess each student's thinking about the 10 questions, and make a permanent record of their ideas for later comparison.
- Allow students to share their individual ideas anonymously without fear of being judged as "right" or "wrong."
- Assess the overall preconceptions of the class in order to better align the content of future lessons to meet students' needs.
- Assess students' growing understanding of these concepts as the module progresses. (For example, have students write their responses to the 10 questions on self-stick notes so that they can remove or revise those answers they discover to be incorrect or inaccurate.)

STUDENT MISCONCEPTIONS

This lesson addresses 10 misconceptions about astronomy that are commonly held by both students and adults. Some of those common misconceptions are—

- Students may state that points of light in the night sky are stars. (Some points of light may be planets, galaxies, or satellites.)
- Students may not think of the Sun as a star because it is not visible at night. (Although the Sun is dominant and warm and the standard conception of a star is distant and cold, the Sun is a star.)
- Students may believe that the stars "come out at night" and are not always present in the sky. (The Sun's light prevents us from seeing stars during the day.)
- Students may think that there are thousands of stars in our solar system. (There is just one star in our solar system—the Sun.)
- Students may think that lunar phases are caused by Earth's shadow being cast on the Moon. They may believe that a full moon occurs when the Moon is closest to the Sun, where it can receive the most light, and that a new moon occurs when Earth blocks the Sun's light from reaching the Moon. (Phases are the result of the Moon's relative position to Earth. See Lesson 5 Background.)
- Students may believe that seasons are related to Earth's distance from the Sun. (Seasons are the result of Earth's tilt on its axis.)
- Many students may believe that gravity is selective about what it affects and when it does, and that gravity must be stronger at great distances in order to exert its pull. Students also may think that planets with slow or no rotations have little or no gravity. (See Lesson 15 for information on gravity.)

These misconceptions are reinforced by our use of terms such as "sunrise" and "sunset" and common phrases such as "shooting star," "the Moon changed its shape," and "the Sun moved across the sky." As soon as students are

conceptually ready, it is important to use more accurate terms and phrases—such as “meteor” and “the Sun’s apparent motion across the sky”—within the context of concrete investigations. Although it may be impossible to dispel students’ misconceptions about space during this module, many can be corrected by repeated firsthand experiences. One source that describes the research behind these and other student misconceptions is: Jeffrey Paul Adams and Timothy Frederick Slater, “Astronomy in the National Science Education Standards,” *Journal of Geoscience Education*, v. 48, 2000, p. 39.

READING SELECTION

The reading selection “Astronomy: Looking Back” in Lesson 1 in the Student Guide describes the history of astronomy and the contributions of Ptolemy, Copernicus, Brahe, and Galileo.

MATERIALS FOR LESSON 1

For the teacher

- 2 large sheets of paper (such as newsprint or bulletin board paper), approx. 65 cm × 90 cm*
- 1 set of wide-tipped markers, assorted colors*
- 10 file folders (or 10 additional large sheets of paper)*
- 1 set of 10 *Earth in Space* photo cards, including the following:
 - Wristwatch (labeled A)
 - Seasons (labeled B)
 - Lunar phases (labeled C)
 - Solar and lunar eclipse (labeled D)
 - Night sky (labeled E)
 - Landforms (labeled F)
 - Earth-Moon system (labeled G)
 - Solar system (labeled H)
 - Tide (labeled I)
 - Comet (labeled J)

Masking tape*

- 1 transparency (optional, to replace 1 sheet of newsprint)*
- Overhead projector (optional)*

For each student

- 1 science notebook*
- 10 self-stick notes, 3" × 5"
- 1 set of colored pencils, crayons, or fine-point markers*

PREPARATION

1. Use a transparency or a large sheet of paper to create a sheet for brainstorming. At the top of the sheet write, “What We Know About the Solar System.” Write the date on the sheet and display it.
2. Fold a second sheet of large paper in half lengthwise. (Do not use a transparency.) Label the left-hand column “What We Want to Know About the Solar System.” Label the right-hand column “What We Now Know About the Solar System.” Set it aside until the end of the lesson. You will want to keep the list posted throughout the module so that students can add and answer questions.
3. Plan how to divide the class into groups of four before the lesson begins. Groups should sit together. Decide how you will identify each group. For example, assign a number, letter, or color to each group.
4. Write the question or questions that appear on the back of each photo card on the front of a file folder. Label the questions A–J. Place each photo card in its corresponding folder or attach the photo card to the outside of the folder, as shown in Figure 1.1. Write the question in small print inside the folder. Students will later post their responses beneath the question, as discussed in Procedure Step 5.

*Needed, but not supplied



NOTE You may want to write each question on a separate sheet of large paper. This way, during Procedure Step 5 students can post the final consolidated responses on the large sheets, which can remain on display in your classroom throughout the module.

5. Make sure that each student has a science notebook to use throughout the module. Students will use their notebooks to brainstorm and record ideas, answer questions, and react to reading selections. (See “Teaching Strategies” in the front matter of this guide for more information on using notebooks in the science classroom.)

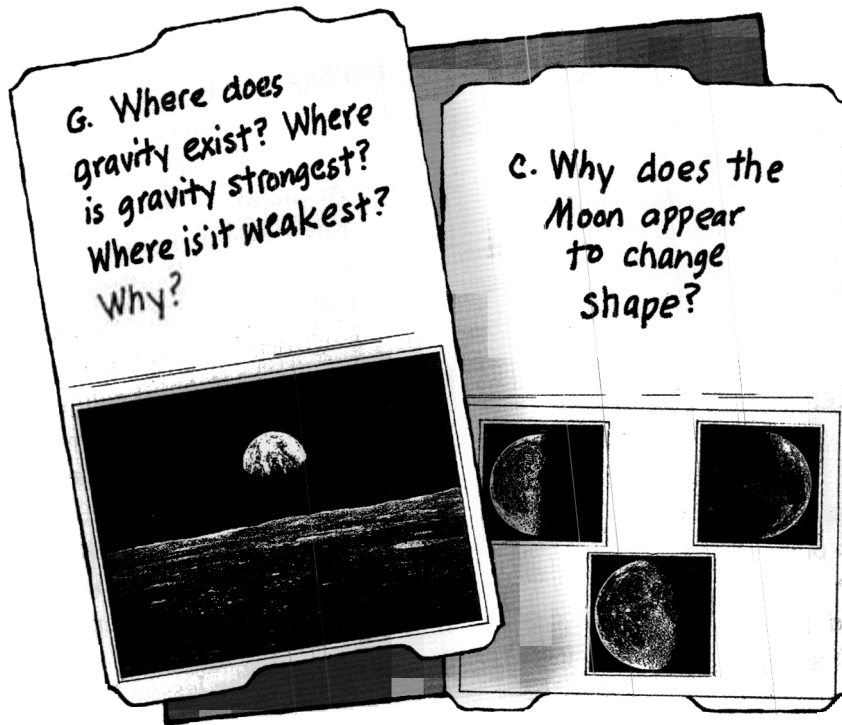


Figure 1.1 Write the questions in large print on the front of each file folder. Label the question with a letter. Place the photo card inside the folder. As an option, attach the corresponding photo card to the back of the folder so that the question and photo are facing the same direction when the folder is opened, as shown.

Getting Started

1. Ask students to read the Introduction and Objectives for this lesson in the Student Guide.
2. Have students individually record in their notebooks 5–10 things they know about the solar system and Earth in space. Many students will write one-word responses such as “Sun” or “planets.” To get a better assessment of their current understanding, encourage students to write in complete sentences. Remind them to date and title their notebook entries.
3. Invite students to share what they know about the solar system. Record their ideas on the brainstorming sheet you created. You may want to limit this discussion to about 5 minutes. Inform students that you are only surveying their ideas at this point. Sample responses are shown in Figure 1.2.

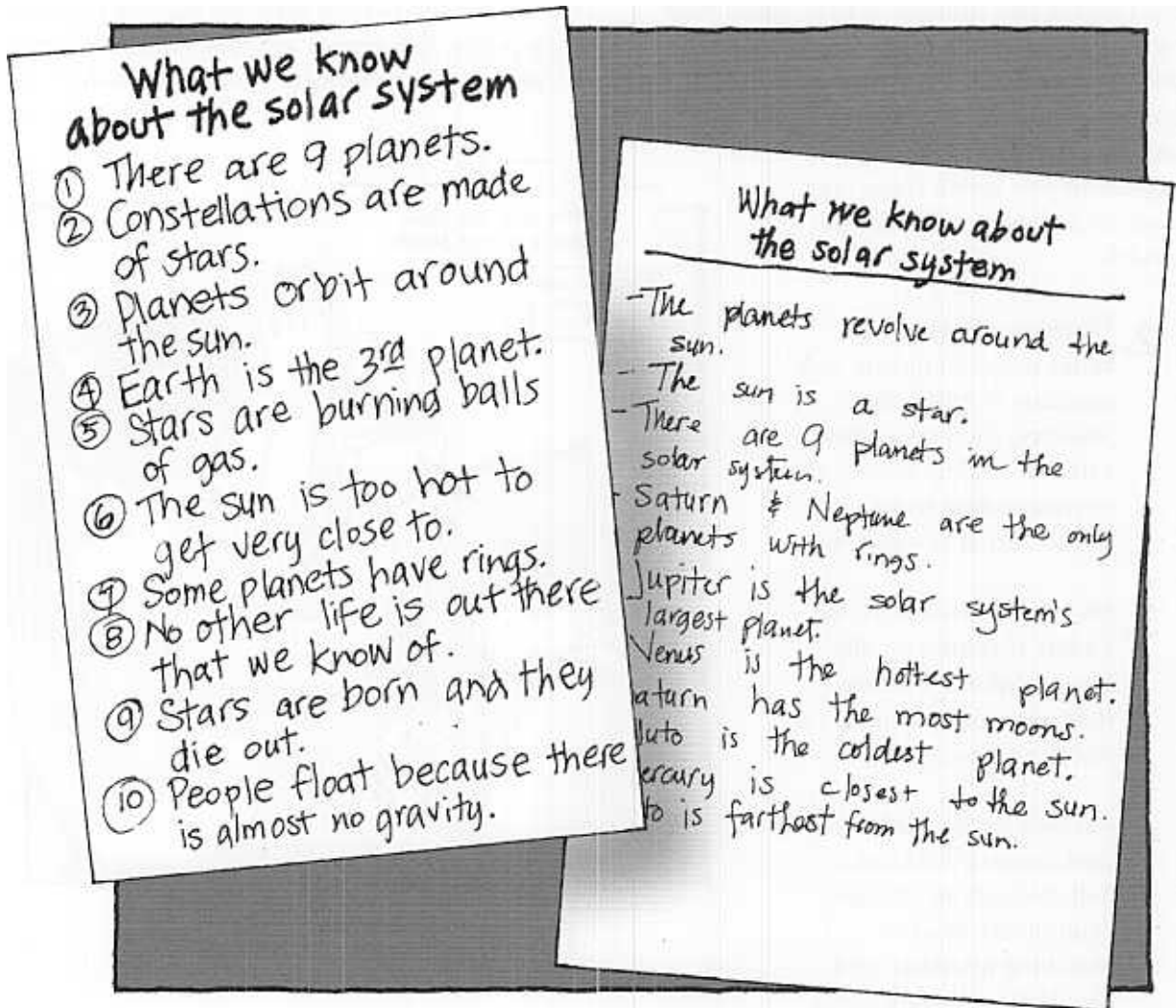


Figure 1.2 Sample brainstorming responses

Inquiry 1.1

Examining Our Ideas About Space

PROCEDURE

1. Ask students to answer questions A–J under SG Procedure Step 1 individually in their notebooks. If there is more than one question per letter, remind students to answer each question.

NOTE Many students hesitate to record answers they believe may be wrong. Inform students that the point of this exercise is to examine their *current* views about space, that their answers will not be graded, and that they will share their answers anonymously. Remind students that they will have an opportunity to revisit these questions as they work through the module.

2. Distribute 10 self-stick notes to each student. Ask students to write their answers, each on a separate self-stick note with the corresponding letter (A–J) in the corner of the note.
3. Show students the 10 file folders prepared for this lesson. Inform students that each folder contains a photo and one question.
4. Put one to two folders on each group's work area. Tell students to examine each photo, read its matching question, and post their self-stick notes inside each matching folder. Once everyone in a

group is finished, students should pass the folder(s) on to the next group.

5. Once all folders have circulated, assign one or two completed folders to each group of four students. Ask each group to work together to post their responses, as outlined in SG Procedure Steps 4–6 (see Figure 1.3).

NOTES

- To ensure that all members of each group work cooperatively, you may instruct the groups to assign a job to each member, such as recorder, reporter, questioner, and materials manager, and clarify the tasks to be done by each.



Figure 1.3 Students should post their consolidated responses on the inside of each folder.

- If you teach more than one class, students in subsequent classes should review any answers that were posted in the folder by the previous class(es), and post only new or original answers.
6. Invite each group to use its folder to report its findings to the class. Encourage brief discussion and debate at this time, but avoid addressing any questions or concerns in detail. Inform students that they will address each of the 10 questions as the lessons in the module progress and that they will be able to make changes in their answers by removing self-stick notes with invalid responses, or by adding notes that may reflect their new understanding.

REFLECTIONS

1. Discuss the following questions as a class (responses will vary):

Are any of the questions (A–J) you answered during Inquiry 1.1 related to the same topic? Explain your answer by giving an example. (Students may recognize, for example, that questions dealing with stars are similar to questions about the Sun. Also, Questions G, H, and I all deal with gravity, since tides and planetary orbits are associated with gravitational influences.)

What can we learn about Earth by studying the solar system? (If students have difficulty with this question, use a specific example, such as: How can your observations of the Sun tell you more about Earth?)

How is Earth different from other planets? How is Earth similar to other planets? (Expect students to focus on concrete physical features at this point, such as composition—rocky or gaseous, relative size, and distance from the Sun.)

2. Ask students to record in their notebooks their questions about Earth in space and the solar system in general. Have them label the questions “What I Want To Know About the Solar System.”
3. Ask students to share their questions with the class. Record their questions on self-stick notes and place them in the left-hand column of the newsprint that you labeled for this purpose. Let them know that you will not answer their questions at this point, but that they will try to answer these questions as the module progresses. As they do, they will move questions over to the right-hand column.
4. Ask students to draw a “line of learning” in their notebooks below their questions from Inquiry 1.1. Below that line, ask them to summarize what they learned (or did) in this lesson.

NOTES

- When applicable, have students answer the questions in the “Reflecting on What You’ve Done” section in their notebooks. Close each lesson by discussing as a class their answers to these questions and clarifying their ideas. This process of reflection helps students bring together all the information addressed in the lesson. Try to give students time to summarize what they learned at the end of each lesson.
- Throughout the module, encourage students to use self-stick notes to add to and revise the class’s brainstorming list of questions.

HOMEWORK

Ask students to complete the historical reading selection “Astronomy: Looking Back.” Have them answer the questions in their science notebooks.

EXTENSIONS

■ Information Technology

1. Have students visit an astronomy Web site and look up “Earth.” What information did they find about Earth that they did not know before? Which information about Earth relates to Earth as a planet within the solar system? Which information is independent of Earth as a planet? See the National Science Resources Center’s Web site (<http://www.si.edu/nsrc>) for specific links.

■ Language Arts ■ History

2. Ask students to research the history of astrology. Did astrology grow out of mythology? If so, how?

■ History ■ Technological Design

3. Students can research ancient structures designed and built to observe the sky. Stonehenge is one example. Challenge students to design a model, or miniature version, of the structure.

■ Art

4. The discovery of planets occurred when ancient people realized that some points of light moved among the patterns of “fixed” stars. By poking holes through black construction paper, students can create model constellations—“pictures” formed by the positions of these stars.

■ Science

5. Skywatching is an enjoyable hobby. Field guides and sky charts can help students identify and locate the stars, constellations, and planets in the night sky. Astronomy and science magazines can help keep students in touch with events in the sky and with recent discoveries of astronomy and the space program.

ASSESSMENT

Students’ individual notebook responses, as well as their group reports concerning each question, will reveal their preconceived ideas about Earth as a planet. The information you gather about students’ knowledge of the solar system serves as the first part of the pre- and post-module assessments, which are an integral part of teaching the module. The overall assessment for Part 1: Sun-Earth-Moon System is in Lesson 9. The matching post-module assessment is in Lesson 22. As the module progresses, pay particular attention to how students’ knowledge of Earth as a planet, and of the solar system as a whole, progresses from ideas about each independent planet to ideas about relationships among planets. Assess students’ ability to think of the planets as a system in which Earth is one part. Look for evidence of growing understanding that Earth is a planet and that some of the processes that exist on Earth exist on other planets as well.

Throughout the module, students will learn skills that are basic to the practice of science: hypothesizing, observing, recording, comparing, designing, analyzing, concluding, and working cooperatively. You can assess students’ progress in these areas by observing and talking with them as they work, and by reviewing individual student products. Both individual and group assessments are important. “Teaching Strategies” in the front matter of this guide presents a detailed discussion of assessing student learning.

PREPARATION FOR LESSON 3

In Lesson 3 and later lessons, you will need to use the CD-ROM *Starry Night Backyard*[™], developed by SPACE.com. If you have not yet done so, you will need to order *Starry Night Backyard* from SPACE.com immediately, by completing the prepaid order sheet in the materials kit. Allow 1–2 weeks for delivery *after* the voucher has been received by SPACE.com.