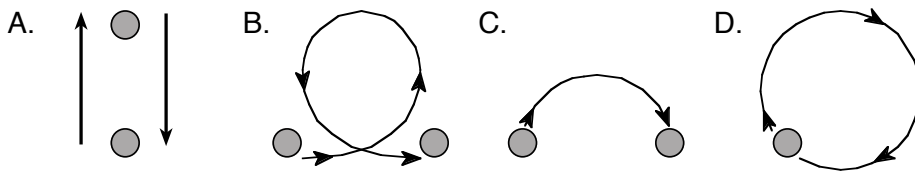


ASTRONOMY/SPACE SCIENCE TEST

For some questions, there may be more than one correct answer. However, each question has only one best answer. Choose the single best answer from the five choices for each question.

1. About what time of year would you have the most daylight?
 - a. The first day of Spring
 - b. The first day of Summer
 - c. The first day of Fall
 - d. The first day of Winter
 - e. The length of daylight is the same all year.
2. Isabella looks outside and sees a full Moon. When should she look if she wants to see that it is full again?
 - a. Three days
 - b. About two weeks
 - c. About one month
 - d. One year
 - e. Nobody knows because it changes often.
3. Imagine Earth had no air, rain, or clouds. What would the temperatures be like during the night?
 - a. Temperatures at night would be the same.
 - b. The night would get much hotter.
 - c. The night would get much colder.
 - d. The night would only warm up at the North and South Poles.
 - e. There would not be any night.
4. Steve's bedroom window faces east. He woke up because the rising Sun was shining on him in bed. If Steve was in bed at sunset, would the setting Sun shine on him through the same window?
 - a. No. The setting Sun could not shine through the same window.
 - b. No. But the rising Sun will shine on him every clear morning.
 - c. Yes. The setting Sun will shine through the window exactly as it did when it rose.
 - d. Yes. But the Sun will be near the left edge of the window.
 - e. Yes. But the Sun will be near the right edge of the window.
5. Which of the following best shows how the Sun moves over the course of a day?



- a. A
- b. B
- c. C
- d. D
- e. The path of the Sun cannot be predicted.

6. Julia is sitting outside on a clear, dark night a few hours after sunset. Which direction in the sky must she look to be able to see stars?
 - a. She will only see stars directly overhead.
 - b. She must look in the direction the Sun rises.
 - c. She must look where the Sun set.
 - d. She must look along the horizon.
 - e. She can look anywhere in the sky to see stars.

7. Earth would be covered with ice if we did not have:
 - a. sunlight.
 - b. the tilt of Earth's axis.
 - c. volcanoes.
 - d. human technology.
 - e. the ozone layer.






8. You are outside on a clear night. You look overhead and see a bright star. If you looked overhead three hours later, you would expect to see:
 - a. the star in the same place.
 - b. the star farther east.
 - c. the star farther west.
 - d. the star would be no longer visible.
 - e. It is impossible to know.

9. What is the largest source of heat for the surface of Earth?
 - a. Volcanoes
 - b. The ozone layer
 - c. Cars, factories, and power stations
 - d. The Sun
 - e. Warm-blooded animals

10. On a dark moonless night far from any bright lights, how do the stars appear to be spread across the sky?
 - a. In circular patterns.
 - b. In square patterns.
 - c. In triangular patterns.
 - d. In other patterns (rectangles, spirals).
 - e. Scattered unevenly.

GO TO QUESTION 11 >>

11. One evening Nicholas looked up at the sky and noticed the positions of the Moon, some stars, and a cloud. Think about the distance to the Moon, stars, and clouds. Which picture best shows the order of these objects?

A	B	C	D	E
				
The stars are in front of the cloud and the cloud is blocking the Moon.	The Moon is in front of the cloud and the cloud is blocking the stars.	The cloud is in front of the Moon; the stars are in front of the Moon.	The cloud is in front of the Moon; the Moon is blocking the stars.	The Moon is in front of the stars; the stars are in front of the cloud.






12. As your eyes adjust to the darkness outside, you are able to see many stars overhead in the night sky. Which one of the following do you think you would see?
- The stars are all the same brightness.
 - Stars can be found which are very bright, very dim, and everything in between.
 - There is only one very bright star; all the rest are equally dim.
 - Stars fall into only two classes, very bright or very dim.
 - It is impossible to compare the brightness of stars.
13. At what time of night should you try to see the North Star?
- Early in the evening
 - At midnight
 - A few hours before sunrise
 - Any time of night
 - Never

ASTRONOMY/SPACE SCIENCE TEST

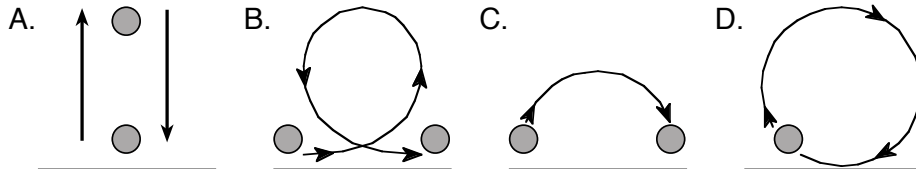
For some questions, there may be more than one correct answer. However, each question has only one best answer. Choose the single best answer from the five choices for each question.

1. What is the largest source of heat for the surface of Earth?
 - a. Volcanoes
 - b. The ozone layer
 - c. Cars, factories, and power stations
 - d. The Sun
 - e. Warm-blooded animals
2. On a dark moonless night far from any bright lights, how do the stars appear to be spread across the sky?
 - a. In circular patterns.
 - b. In square patterns.
 - c. In triangular patterns.
 - d. In other patterns (rectangles, spirals).
 - e. Scattered unevenly.
3. Earth would be covered with ice if we did not have:
 - a. sunlight.
 - b. the tilt of Earth's axis.
 - c. volcanoes.
 - d. human technology.
 - e. the ozone layer.
4. At what time of night should you try to see the North Star?
 - a. Early in the evening
 - b. At midnight
 - c. A few hours before sunrise
 - d. Any time of night
 - e. Never
5. Imagine Earth had no air, rain, or clouds. What would the temperatures be like during the night?
 - a. Temperatures at night would be the same.
 - b. The night would get much hotter.
 - c. The night would get much colder.
 - d. The night would only warm up at the North and South Poles.
 - e. There would not be any night.
6. You are outside on a clear night. You look overhead and see a bright star. If you looked overhead three hours later, you would expect to see:
 - a. the star in the same place.
 - b. the star farther east.
 - c. the star farther west.
 - d. the star would be no longer visible.
 - e. It is impossible to know.

7. One evening Nicholas looked up at the sky and noticed the positions of the Moon, some stars, and a cloud. Think about the distance to the Moon, stars, and clouds. Which picture best shows the order of these objects?

A	B	C	D	E
				
The stars are in front of the cloud and the cloud is blocking the Moon.	The Moon is in front of the cloud and the cloud is blocking the stars.	The cloud is in front of the Moon; the stars are in front of the Moon.	The cloud is in front of the Moon; the Moon is blocking the stars.	The Moon is in front of the stars; the stars are in front of the cloud.

8. As your eyes adjust to the darkness outside, you are able to see many stars overhead in the night sky. Which one of the following do you think you would see?
- The stars are all the same brightness.
 - Stars can be found which are very bright, very dim, and everything in between.
 - There is only one very bright star; all the rest are equally dim.
 - Stars fall into only two classes, very bright or very dim.
 - It is impossible to compare the brightness of stars.
9. Which of the following best shows how the Sun moves over the course of a day?



- A
 - B
 - C
 - D
 - The path of the Sun cannot be predicted.
10. Steve's bedroom window faces east. He woke up because the rising Sun was shining on him in bed. If Steve was in bed at sunset, would the setting Sun shine on him through the same window?
- No. The setting Sun could not shine through the same window.
 - No. But the rising Sun will shine on him every clear morning.
 - Yes. The setting Sun will shine through the window exactly as it did when it rose.
 - Yes. But the Sun will be near the left edge of the window.
 - Yes. But the Sun will be near the right edge of the window.

GO TO QUESTION 11 >>

11. Isabella looks outside and sees a full Moon. When should she look if she wants to see that it is full again?
- Three days
 - About two weeks
 - About one month
 - One year
 - Nobody knows because it changes often.
12. Julia is sitting outside on a clear, dark night a few hours after sunset. Which direction in the sky must she look to be able to see stars?
- She will only see stars directly overhead.
 - She must look in the direction the Sun rises.
 - She must look where the Sun set.
 - She must look along the horizon.
 - She can look anywhere in the sky to see stars.
13. About what time of year would you have the most daylight?
- The first day of Spring
 - The first day of Summer
 - The first day of Fall
 - The first day of Winter
 - The length of daylight is the same all year.

K-4 Astronomy and Space Science Tests¹

The tests in this section contain items related to the four K-4 standards in astronomy and space science. The standards are stated below. The source of each standard is given in parentheses: *NSES* = National Research Council's "National Science Education Standards"; *Benchmarks* = American Association for the Advancement of Science's "Benchmarks for Science Literacy."

K-4 Astronomy Standard 1:

"The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described." (*NSES*)

K-4 Astronomy Standard 2:

"The sun provides the light and heat necessary to maintain the temperature of the earth." (*NSES*)

K-4 Astronomy Standard 3:

"There are more stars in the sky than anyone can easily count, but they are not scattered evenly, and they are not all the same in brightness or color." (*Benchmarks*)

K-4 Astronomy Standard 4:

"Objects in the sky have patterns of movement. The sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. The moon moves across the sky on a daily basis much like the sun. The observable shape of the moon changes from day to day in a cycle that lasts about a month." (*NSES*)

The items are identical on both test forms, but arranged in different sequences so that the forms can be used as a pretest/post-test pair (either form may be used as the pretest). Either form can be used by itself as a diagnostic test.

The K-4 tests are intended for use primarily with 5th grade students. Project MOSART did not develop tests for use with students in grades K-4 due to the difficulty of writing reliable multiple choice items for students whose reading levels may vary widely. The tests can also be administered to any persons who possess at least a 5th grade reading level fluency in English.

NOTE: Administering the tests to anyone with less than the indicated minimum reading level may result in invalid test results due to the test performing more as a reading comprehension test rather than as a science test.

¹ Test items for the K-4 astronomy and space science standards were developed with funding from NASA's Science Mission Directorate, via the Universe Education Forum at the Harvard-Smithsonian Center for Astrophysics.

Item # Form 611	Item # Form 612	Text of item	Std. ²	Correct response & percent ³ responding correctly	Commentary ⁴
1	13	About what time of year would you have the most daylight? a. The first day of Spring b. The first day of Summer c. The first day of Fall d. The first day of Winter e. The length of daylight is the same all year.	1	B: 60%	The majority of students responded correctly to this item. One incorrect response, A, attracted more than 20% (24% students). No other response received more than 10% of the responses.
2	11	Isabella looks outside and sees a full Moon. When should she look if she wants to see that it is full again? a. Three days b. About two weeks c. About one month d. One year e. Nobody knows because it changes often.	4	C: 47%	One incorrect response, B, attracted more than 20% (21%), indicating that some elementary school students do not comprehend the relationship of the Moon phases to the month. No other response received more than 10% of the responses.
3	5	Imagine Earth had no air, rain, or clouds. What would the temperatures be like during the night? a. Temperatures at night would be the same. b. The night would get much hotter. c. The night would get much colder. d. The night would only warm up at the North and South Poles. e. There would not be any night.	2	C: 35%	Interestingly, more students chose B (40%) than chose the correct response. Students may have been thinking of the possible cooling effects that clouds and rain can have and thought their absence would lead to higher temperatures. No other response was chosen by more than 10% of the students.

² These test items are valid psychometrically and represent standards commonly included in elementary astronomy and space science curricula.

³ Students (n=825) were selected randomly in classes to be a nationally representative sample of all grade 5 students in U.S. public and private schools.

⁴ The commentary reflects item response patterns. Common misconceptions in astronomy are discussed in a separate section.

Item # Form 611	Item # Form 612	Text of item	Std. ²	Correct response & percent ³ responding correctly	Commentary ⁴
4	10	<p>Steve's bedroom window faces east. He woke up because the rising Sun was shining on him in bed. If Steve was in bed at sunset, would the setting Sun shine on him through the same window?</p> <p>a. No. The setting Sun could not shine through the same window.</p> <p>b. No. But the rising Sun will shine on him every clear morning.</p> <p>c. Yes. The setting Sun will shine through the window exactly as it did when it rose.</p> <p>d. Yes. But the Sun will be near the left edge of the window.</p> <p>e. Yes. But the Sun will be near the right edge of the window.</p>	4	A: 33%	Choosing the correct response indicates that students understand the path of the Sun across the sky during the day. However, more students chose B (37%) than chose the correct response. It may be that students are not aware of the changes in the geographical point of sunrise (such as that the Sun might rise outside the boundaries of Steve's window). No other response was chosen by more than 10% of the students.
5	9	<p>Which of the following best shows how the Sun moves over the course of a day?</p> <p>See figure choices in item on test.</p>	4	C: 42%	35% of students chose D, which shows a circle with the Sun moving in a complete circle. No other item was chosen by more than 10% of the students.
6	12	<p>Julia is sitting outside on a clear, dark night a few hours after sunset. Which direction in the sky must she look to be able to see stars?</p> <p>a. She will only see stars directly overhead.</p> <p>b. She must look in the direction the Sun rises.</p> <p>c. She must look where the Sun set.</p> <p>d. She must look along the horizon.</p> <p>e. She can look anywhere in the sky to see stars.</p>	3	E: 49%	Almost a majority chose the correct response. Three other options each attracted more than 10% of responses, with B being the most popular (19%), followed by A (12%) and C (11%), but these may represent random choices or guessing given the overall low frequencies.

Item # Form 611	Item # Form 612	Text of item	Std. ²	Correct response & percent ³ responding correctly	Commentary ⁴
7	3	<p>Earth would be covered with ice if we did not have:</p> <ol style="list-style-type: none"> sunlight. the tilt of Earth's axis. volcanoes. human technology. the ozone layer. 	2	A: 63%	63% of students chose the correct response, suggesting that more than one-third of students do not comprehend the effects of the other factors on the climate. The largest percentage (15%) selected E, possibly because of the association of ice-covered Antarctica with the "hole" in the ozone layer.
8	6	<p>You are outside on a clear night. You look overhead and see a bright star. If you looked overhead three hours later, you would expect to see:</p> <ol style="list-style-type: none"> the star in the same place. the star farther east. the star farther west. the star would be no longer visible. It is impossible to know. 	1	C: 32%	While the correct choice was most frequently chosen, B and E each received over 20% of the responses, indicating that few students understand the relationship between the night sky and the rotation of Earth on its axis.
9	1	<p>What is the largest source of heat for the surface of Earth?</p> <ol style="list-style-type: none"> Volcanoes The ozone layer Cars, factories, and power stations The Sun Warm-blooded animals 	1	D: 72%	A large majority of students answered correctly. It seems likely that students with incorrect responses on this item really have very little idea about energy in the Earth system. Fewer than 10% chose any other one option.
10	2	<p>On a dark moonless night far from any bright lights, how do the stars appear to be spread across the sky?</p> <ol style="list-style-type: none"> In circular patterns. In square patterns. In triangular patterns. In other patterns (rectangles, spirals) Scattered unevenly. 	3	E: 67%	Although no wrong choice attracted many responses, the fact that overall one-third of students did not respond correctly suggests that many are unfamiliar with the night sky.

Item # Form 611	Item # Form 612	Text of item	Std. ²	Correct response & percent ³ responding correctly	Commentary ⁴
11	7	<p>One evening Nicholas looked up at the sky and noticed the positions of the Moon, some stars, and a cloud. Think about the distance to the Moon, stars, and clouds. Which picture best shows the order of these objects?</p> <p>See figure choices in item on test.</p>	1	D: 42%	While the most popular choice was the correct one, nearly 20% of students chose either C (showing both the cloud and stars in front of the Moon) or E (showing the Moon and stars in front of cloud). This suggests that students may not understand the relationships between Earth and objects in the sky.
12	8	<p>As your eyes adjust to the darkness outside, you are able to see many stars overhead in the night sky. Which one of the following do you think you would see?</p> <ol style="list-style-type: none"> The stars are all the same brightness. Stars can be found which are very bright, very dim, and everything in between. There is only one very bright star; all the rest are equally dim. Stars fall into only two classes, very bright or very dim. It is impossible to compare the brightness of stars. 	3	B: 54%	Slightly more than one-half of students recognize that stars in the night sky vary in brightness. The students who did not respond correctly had no specific response pattern, indicating that the choice was random and that they were likely guessing.
13	4	<p>At what time of night should you try to see the North Star?</p> <ol style="list-style-type: none"> Early in the evening At midnight A few hours before sunrise Any time of night Never 	1	D: 34%	40% of students incorrectly chose that the North Star is visible only at midnight (B). It is reasonable to infer from this response rate that many students are unfamiliar with the night sky.

Major Misconceptions in K-4 Astronomy/Space Science

Listed below are some student astronomy and space science misconceptions. The list is not intended to be exhaustive, but rather a summary of some of the more common prior ideas we identified from our analysis of the student response patterns to the items on the tests.

- The Sun follows the same path across the sky each day, rising due east and setting due west, and passing directly overhead at noon.
- The Sun goes around the Earth once each day.
- Stars and constellations do not rise and set, but remain in the same location throughout the night.

The following resources are useful for additional background information about students' science misconceptions:

Comins, N., *Heavenly Errors; Misconceptions About the Real Nature of the Universe*, New York: Columbia Press (2001).

Driver, R. (Ed.), *Children's Ideas in Science*, Philadelphia: Open University Press (1985).

Driver, R., *Pupil as Scientist?*, Philadelphia: Open University Press (1983).

Agan, L., "Stellar Ideas: Exploring Students' Understanding of Stars" in *Astronomy Education Review*: <http://aer.noao.edu/cgi-bin/article.pl?id=95>.

Agan, L. & Sneider, C., "Learning About the Earth's Shape and Gravity: A Curriculum Guide for Teachers and Curriculum Developers" in *Education Review*: <http://aer.noao.edu/cgi-bin/article.pl?id=65>.