

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.

- How many planets have orbits between Earth and the Sun?
 - None; Earth is the closest planet to the Sun.
 - 1
 - 2
 - 3
 - More than three planets.
- An eclipse of the Moon can only occur:
 - when the Moon passes between Earth and the Sun.
 - when the Sun passes between Earth and the Moon.
 - when Earth passes between the Sun and the Moon.
 - when the Moon is closest to Earth.
 - when the Moon is farthest from Earth.
- Calcutta, India, is half way around the Earth east of Chicago. If it is noon in Chicago, in Calcutta it would be about:
 - Sunrise
 - Sunset
 - Noon
 - Midnight
 - Noon the next day.
- Imagine that the Moon suddenly disappeared. What would happen to the tides in Earth's oceans?
 - The tides would be the same as before the Moon disappeared.
 - There would only be smaller tides caused by the Sun.
 - There would be a permanent low tide everywhere.
 - There would be a permanent high tide everywhere.
 - There would be no tides.
- Of the days below, which has more hours of daylight in Denver?
 - June 21
 - July 21
 - August 21
 - September 21
 - All dates are the same.
- Which answer shows the most accurate pattern of the three objects in order from closest object to Earth to farthest from Earth?
 - center of Milky Way → Andromeda galaxy → North Star
 - center of Milky Way → North Star → Andromeda galaxy
 - Andromeda galaxy → North Star → center of Milky Way
 - North Star → Andromeda galaxy → center of Milky Way
 - North Star → center of Milky Way → Andromeda galaxy

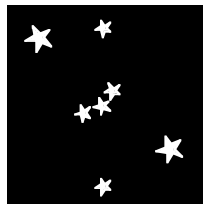
7. How far away is the closest star to us beyond our Sun?
 - a. About the same distance as the Sun.
 - b. Ten times farther.
 - c. One hundred times farther.
 - d. One thousand times farther.
 - e. More than a thousand times farther.

8. As Earth and Mars move they:
 - a. exchange positions with one another.
 - b. both get farther from the Sun than Jupiter.
 - c. move randomly through the solar system.
 - d. travel around the Sun with Earth always closer.
 - e. This isn't a good question because planets don't move.

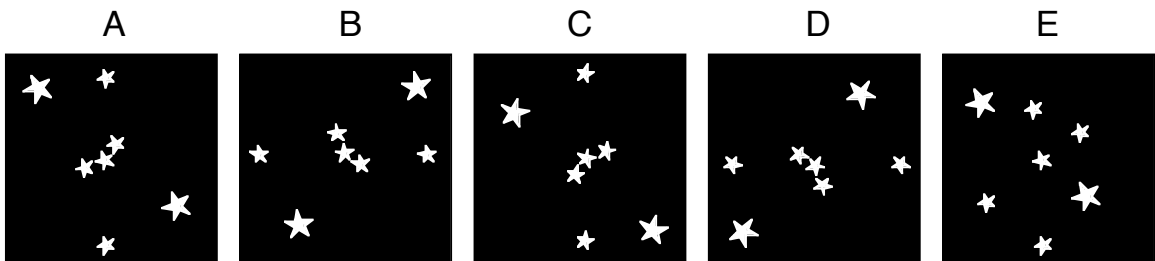
9. How long does it take for Earth to turn once on its axis?
 - a. One day.
 - b. One week.
 - c. One month.
 - d. One year.
 - e. It never happens.

10. Our solar system contains:
 - a. One average star
 - b. Several stars spread across space
 - c. One older, dimmer star, and one younger, brighter star
 - d. Three stars
 - e. No stars

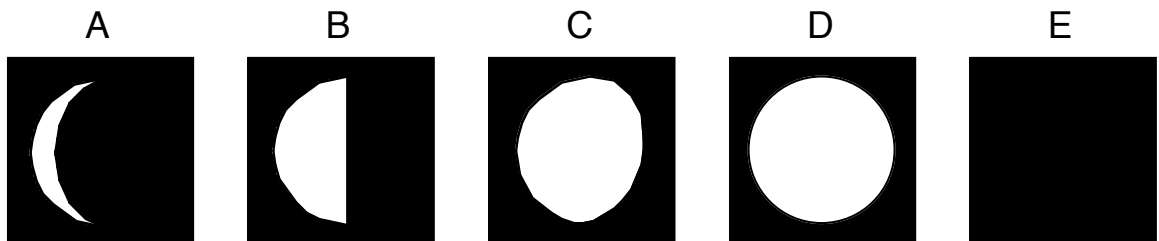
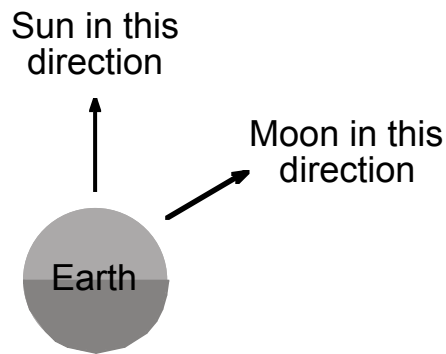
11. You go outside one night and see the pattern of stars in the southern sky shown below.



Which of the views below shows how the stars would look 6 hours later?



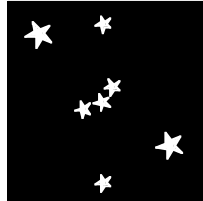
12. If the Sun stopped shining right now, the soonest it could be noticed on Earth would be:
- a few seconds.
 - a few minutes.
 - a few hours.
 - a few days.
 - a few years.
13. Which answer shows the most accurate pattern of the three objects in order from closest object to Earth to farthest from Earth?
- Space Shuttle in orbit → Stars → Pluto
 - Pluto → Space Shuttle in orbit → Stars
 - Stars → Space Shuttle in orbit → Pluto
 - Stars → Pluto → Space Shuttle in orbit
 - Space Shuttle in orbit → Pluto → Stars
14. How long does it take for the Moon to go around the Sun?
- One day.
 - One week.
 - One month.
 - One year.
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15. If you could look down from space at Earth from far above its north pole, the Sun and Moon would be in the directions shown by the arrows in the picture below. What would the Moon look like to a person on Earth facing the Moon?



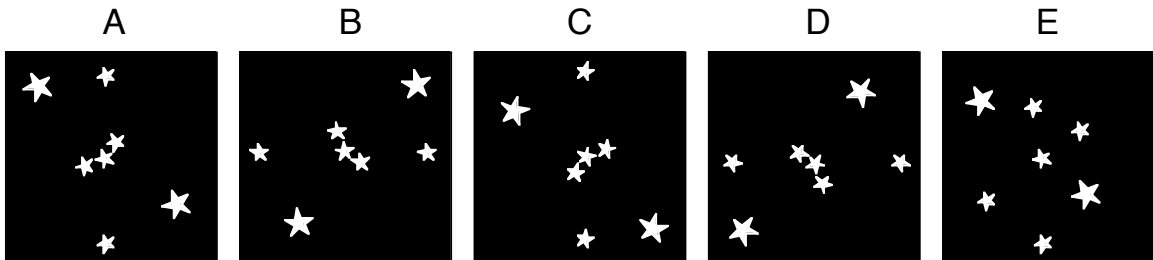
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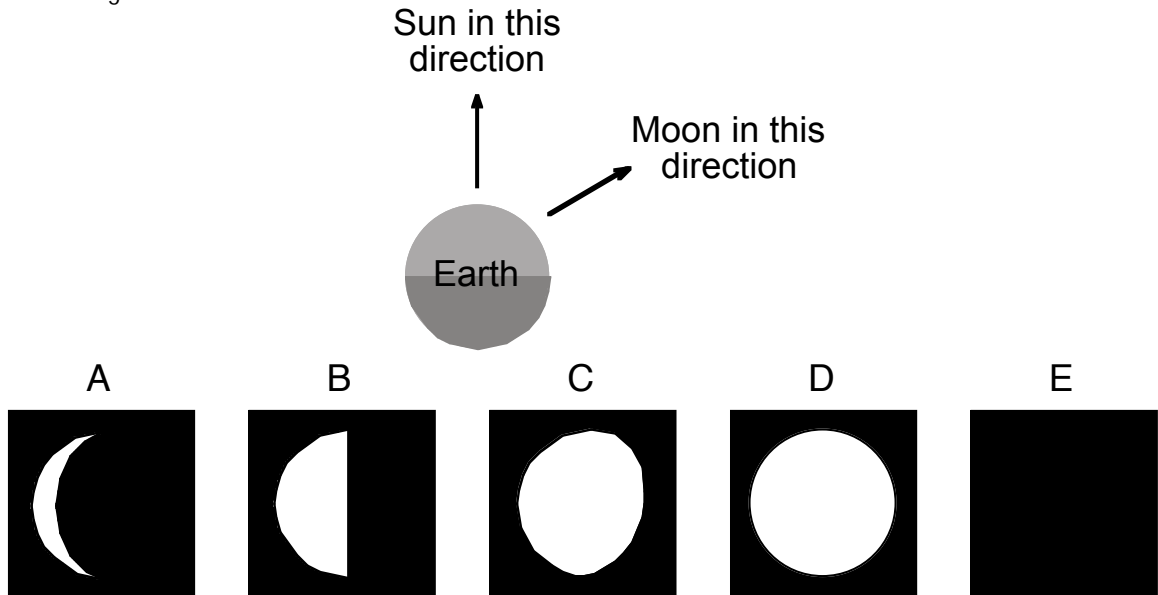
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 - c. a few hours.
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GO TO QUESTION 5>>

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9. Calcutta, India, is half way around the Earth east of Chicago. If it is noon in Chicago, in Calcutta it would be about:
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 - Stars → Pluto → Space Shuttle in orbit
 - Space Shuttle in orbit → Pluto → Stars

Grades 5–8 Astronomy and Space Science Tests¹

The tests in this section contain items related to six grades 5–8 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."

5–8 Astronomy Standard 1:

"The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The sun, an average star, is the central and largest body in the solar system." (*NSES*)

5–8 Astronomy Standard 2:

"Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses." (*NSES*)

5–8 Astronomy Standard 3:

"Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system. Gravity alone holds us to the earth's surface and explains the phenomena of the tides." (*NSES*)

5–8 Astronomy Standard 4:

"The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day." (*NSES*)

5–8 Astronomy Standard 5:

"The patterns of stars in the sky stay the same, although they appear to move across the sky nightly, and different stars can be seen in different seasons." (*Benchmarks*)

5–8 Astronomy Standard 6:

"The sun is many thousands of times closer to the earth than any other star. Light from the sun takes a few minutes to reach the earth, but light from the next nearest star takes a few years to arrive. The trip to that star would take the fastest rocket thousands of years. Some distant galaxies are so far away that their light takes several billion years to reach the earth. People on earth, therefore, see them as they were that long ago in the past." (*Benchmarks*)

¹ Test items for the grades 5–8 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.

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 5–8 tests are intended for use primarily with 7th and 8th grade students. The tests can also be administered to any persons who possess at least a 7th 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.

Item # Form 621	Item # Form 622	Text of item	Std. ₂	Correct response & percent responding correctly ³	Commentary ⁴
1	11	How many planets have orbits between Earth and the Sun? a. None; Earth is the closest planet to the Sun. b. 1 c. 2 d. 3 e. More than three planets.	1	C: 52%	The most frequent response to this question was the correct one. The remaining options received equivalent responses (9-12%), suggesting many students do not know this basic fact about the solar system.
2	1	An eclipse of the Moon can only occur: a. when the Moon passes between Earth and the Sun. b. when the Sun passes between Earth and the Moon. c. when Earth passes between the Sun and the Moon. d. when the Moon is closest to Earth. e. when the Moon is farthest from Earth.	2	C: 22%	The most frequent response (53%) was A, indicating either a misconception or confusion about eclipses. The correct response was chosen next most often, with the remaining responses ranging from 14% (B) to 4% (E), suggesting that students do know that a lunar eclipse involves the relative positions of the Moon, Sun and Earth.

² These test items are valid psychometrically and represent standards commonly included in grades 5–8 astronomy curricula. The items do not represent the entire domain of astronomy standards, as presented in the NRC standards and AAAS benchmarks.

³ Students (n=approximately 800 per item) were selected randomly in classes as a nationally representative sample of all grades 6–8 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 621	Item # Form 622	Text of item	Std. 2	Correct response & percent responding correctly ³	Commentary ⁴
3	9	Calcutta, India, is half way around the Earth east of Chicago. If it is noon in Chicago, in Calcutta it would be about: a. Sunrise b. Sunset c. Noon d. Midnight e. Noon the next day.	2	D: 64%	The responses to this item suggest that students understand how local time relates to places on the globe. The use of the term "half way" may cue the students to one-half of the 24-hour span of a day. No other response was chosen by more than 11% of students. This random pattern and the relationship between correct response and total test score also indicate that if students do not grasp this concept, they are probably guessing.
4	8	Imagine that the Moon suddenly disappeared. What would happen to the tides in Earth's oceans? a. The tides would be the same as before the Moon disappeared. b. There would only be smaller tides caused by the Sun. c. There would be a permanent low tide everywhere. d. There would be a permanent high tide everywhere. e. There would be no tides.	3	B: 16%	This item is very interesting in that its response pattern may be due to students using a concept they learned--the Moon causes tides--as the basis for an invalid conclusion. The Moon is <i>mainly</i> responsible for the tides on Earth, but <i>not solely</i> responsible (the Sun contributes a small effect). The most frequent conclusion students made was that tides would not exist without the Moon (E: 45%).

Item # Form 621	Item # Form 622	Text of item	Std. 2	Correct response & percent responding correctly ³	Commentary ⁴
5	10	Of the days below, which has more hours of daylight in Denver? a. June 21 b. July 21 c. August 21 d. September 21 e. All dates are the same.	4	A: 29%	While the date of the summer solstice in the Northern Hemisphere was the most common response, the response pattern indicates less understanding than might be expected. Options B and E each received more than 20% of the responses and the remaining choices each attracted over 10%.
6	12	Which answer shows the most accurate pattern of the three objects in order from closest object to the Earth to farthest from the Earth? See sequence choices in item on test.	1	E: 36%	Although the correct choice was the most popular, 27% chose C, which places the North Star farther away than the Andromeda galaxy. Clearly those students (as well as the 35% combined choosing A, B or D) have little understanding of the relative distance of objects in the sky.
7	14	How far away is the closest star to us beyond our Sun? a. About the same distance as the Sun. b. Ten times farther. c. One hundred times farther. d. One thousand times farther. e. More than a thousand times farther.	6	E: 32%	While the correct response was chosen most often, most students did not seem to fully comprehend this concept. All incorrect options received between 10% and 20% of all responses, indicative of random responses or guessing.

Item # Form 621	Item # Form 622	Text of item	Std. 2	Correct response & percent responding correctly ³	Commentary ⁴
8	2	As Earth and Mars move they: a. exchange positions with one another. b. both get farther from the Sun than Jupiter. c. move randomly through the solar system. d. travel around the Sun with the Earth always closer. e. This isn't a good question because planets don't move.	1	D: 54%	Students clearly believe that the orbits of Earth and Mars do not intersect. No incorrect response received significantly more student responses than the others (ranging between 9% and 13%).
9	6	How long does it take for Earth to turn once on its axis? a. One day. b. One week. c. One month. d. One year. e. It never happens.	2	A: 60%	Although the majority of students understand the astronomical definition of a day, it is interesting to note that 23% chose D (one year).
10	13	Our solar system contains: a. One average star b. Several stars spread across space c. One older, dimmer star, and one younger, brighter star d. Three stars e. No stars	1	A: 32%	Most students selected B (50%). It may be that students have not yet conceptualized the difference between a star with its planets and a galaxy, which includes many stars.

Item # Form 621	Item # Form 622	Text of item	Std. 2	Correct response & percent responding correctly ³	Commentary ⁴
11	3	You go outside one night and see the pattern of stars in the southern sky shown below. Which of the views below shows how the stars would look 6 hours later? See figure on test.	5	B: 20%	The most frequent response to this question is A, which is visually identical to the pattern in the stem (40%). In addition, 19% chose C, a slight variation of the stem figure that could be seen as identical to the stem figure.
12	4	If the Sun stopped shining right now, the soonest it could be noticed on Earth would be: a. a few seconds. b. a few minutes. c. a few hours. d. a few days. e. a few years.	6	B: 25%	Although the distance between Earth and the Sun is a commonly taught fact, 75% of students do not understand that distance in terms of the time required for light to travel from the Sun to Earth. This lack of understanding may hamper students' understanding of distance and scale within our galaxy and the universe.
13	15	Which answer shows the most accurate pattern of the three objects in order from closest object to Earth to farthest from Earth? See sequence choices in item on test.	6	E: 43%	Although the correct choice was chosen most often, most students chose other sequences, suggesting that many students lack a coherent model of distances within the solar system.
14	7	How long does it take for the Moon to go around the Sun? a. One day. b. One week. c. One month. d. One year. e. It never happens.	2	D: 37%	Although the most common choice was the right answer, the second most popular response (E: 29%) indicates that many students do not think of the Moon as traveling around the Sun. Other students thought of the answer in terms of the time the Moon requires to

Item # Form 621	Item # Form 622	Text of item	Std. 2	Correct response & percent responding correctly ³	Commentary ⁴
					go around earth (C: 15%).
15	5	<p>If you could look down from space at Earth from far above its north pole, the Sun and Moon would be in the directions shown by the arrows in the picture below. What would the Moon look like to a person on Earth facing the Moon?</p> <p>See figures on test.</p>	2	A: 18%	Few students responded correctly. Choices B and C received more responses (34% and 25% respectively); choice D was selected as often as A; E (no Moon visible) was chosen least often (7%). Interpretation of the diagrams requires both knowledge of the phases as well as the ability to visualize the Sun-Earth-Moon system.

Major Misconceptions in Grades 5–8 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.

- Locations closer to the equator always have more hours of daylight than do regions farther north or south.
- If the Earth had no moon, there would be no tides.
- The distance to stars is small, with some other stars in our solar system in addition to the Sun.
- Stars and constellations do not rise and set, but remain in the same location throughout the night.
- The same stars and constellations are in the same place in the sky throughout the year, e.g., if you went out every clear night at 9 p.m. and looked south you would see Orion.

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>.