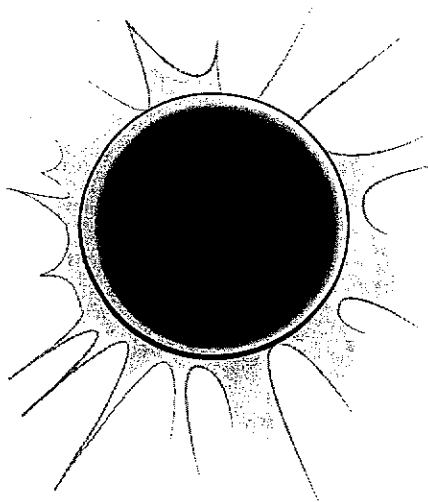


# Moon Phase and Solar Eclipse



During a solar eclipse the Moon appears to completely cover the Sun. What phase is the Moon in just before and after a solar eclipse? Circle the answer that best matches your thinking.

- A** full Moon
- B** new Moon
- C** first quarter Moon
- D** last quarter Moon
- E** It can be in any phase.

Describe your thinking. Provide an explanation for your answer. \_\_\_\_\_

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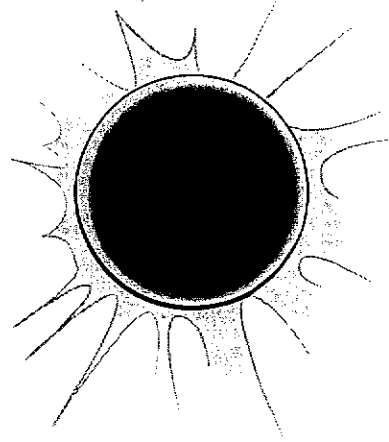
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# Moon Phase and Solar Eclipse

## Teacher Notes



### Purpose

The purpose of this assessment probe is to elicit students' understanding of the Earth-Sun-Moon system well enough to explain the causes of Moon phases and solar eclipses and how these two phenomena are related.

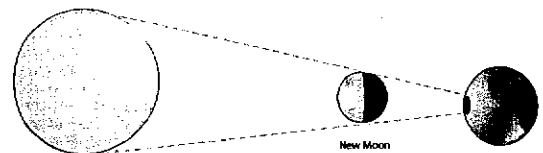
### Related Concepts

Moon: appearance, eclipse, orbit, phase  
Solar system objects: orbits

### Explanation

The best answer is B: new Moon. If students had an opportunity to observe and record Moon phases for a few weeks, they would see that Moon phase is correlated with the angle between the Moon and the Sun. Since the Moon must be between the Earth and the Sun for a solar eclipse to occur, the Sun must be illuminating the side of the Moon that we cannot see, which means it is in the new Moon

phase. This idea is illustrated below (illustration is not to scale):



### Administering the Probe

This probe is best used after middle or high school students have had the opportunity to learn about Moon phases and eclipses. The probe is a challenging question that requires students to stretch a bit to envision the relationship between Moon phases and eclipses. If necessary, show a graphic of each of the Moon phases so that the probe is not dependent on students knowing the terminology.

### Related Ideas in *Benchmarks for Science Literacy* (AAAS 2009)

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#### 3–5 The Universe

- The Earth is one of several planets that orbit the Sun, and the Moon orbits around the Earth.

#### 6–8 The Earth

- The Moon's orbit around the Earth once in about 28 days changes what part of the Moon is lighted by the Sun and how much of that part can be seen from the Earth—the phases of the Moon.

### Related Ideas in *National Science Education Standards* (NRC 1996)

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#### 5–8 Earth in the Solar System

- ★ 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.

#### Related Research

- Danaia and McKinnon (2007) administered tests of astronomy knowledge to 1,920 students in grades 7, 8, and 9 in Australia. One of the questions asked students for the phase of the Moon at a total solar eclipse. The correct answer, “new phase,” was given by only 1% of the seventh graders and 10% of the eighth and ninth graders. About half of the students did not even attempt to answer the question.
- Several instructors of introductory college astronomy courses have used a standard test, the Astronomy Diagnostic Test

(ADT), to measure the effectiveness of their teaching (Hufnagel 2001). For example, Zeilik and Morris (2003) used an early version of the ADT to evaluate a one-semester introductory course in astronomy for college freshmen at the University of New Mexico. One of the questions was: “When the Moon appears to completely cover the Sun (an eclipse), the Moon must be at which phase? (a) full; (b) new; (c) first quarter; (d) last quarter; (e) no particular phase.” At the beginning of the course 49% knew the answer; at the end of the course 90% answered correctly.

- LoPresto (2006) used the ADT as a pre- and posttest for students in an introductory astronomy course at a community college. Test scores averaged over three years found (not surprisingly) that students tended to improve on items that were emphasized during the course. With respect to the question “When the Moon appears to completely cover the Sun (an eclipse), the Moon must be at which phase?” the percentage of students choosing the correct answer (new) increased from an average of 12% on the pretest to 42% on the posttest.

#### Suggestions for Instruction and Assessment

- This probe can be combined with “Solar Eclipse” from *Uncovering Student Ideas in Science, Vol. 4: 25 New Formative Assessment Probes* (Keeley and Tugel 2009).
- Students who have memorized a basic explanation for a solar eclipse (the Moon is between the Earth and the Sun) will probably have difficulty answering this question. However, those who learned to explain both phases and eclipses using a physical model have a good chance of envisioning how the Moon would be moving in its orbit just before passing in front of the Sun, and just after the eclipse.

★ Indicates a strong match between the ideas elicited by the probe and a national standard's learning goal.

- By middle school the great majority of students will have the spatial visualization skills needed to understand solar and lunar eclipses as well as phases. However, it will be important for them to first be clear about the monthly cycle of phases, preferably through their own observations, and then to have an opportunity to model phases.
- It is best to model both phases and eclipses with a single bright bulb in a darkened room to represent the Sun and a ball for each child to hold, representing his or her personal Moon. The students can then see their model Moon go through an entire cycle of phases as they slowly move it in a circle around their heads (with their heads representing Earth). The students will observe that as the Moon gets closer and closer to the Sun it has a thinner and thinner crescent. When it is very close to the Sun it cannot be seen at all—that is the new Moon phase. On rare occasions the Moon passes directly in front of the Sun, causing a solar eclipse—but only during the new Moon phase.
- This assessment probe is a sensitive instrument to determine not only if the students can recall a definition of a solar eclipse but also if they can envision the Moon getting closer and closer to the Sun, and entering the new Moon phase, before a solar eclipse occurs. Therefore, at the high school level, it may be a good idea to have students respond to this probe before beginning a

unit on astronomy. If they have difficulties with it, the activity described above that models Moon phases and eclipses will be appropriate.

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