



The larger of the two moons of Mars, Phobos, passes directly in front of the other, Deimos, in a new series of sky-watching images from NASA's Mars rover Curiosity. Large craters on Phobos are clearly visible in these images from the surface of Mars. No previous images from missions on the surface caught one moon eclipsing the other.

Deimos (small image), and Phobos (large image), are shown together as they actually were photographed by the Mast Camera (Mastcam) on NASA's Mars rover Curiosity on Aug. 1, 2013.

How do we figure out how big something will look when it's far away? We draw a scale model of the object showing its diameter and its distance as the two sides of a triangle. The angle can then be measured. As the distance to the object increases, the 'angular size' of the object will decrease proportionately. A simple proportion can then be written that relates the angles to the lengths of the sides:

$$\frac{\text{Apparent Angle in degrees}}{57.3 \text{ degrees}} = \frac{\text{True diameter in kilometers}}{\text{Distance in kilometers}}$$

Let's see how this works for estimating the sizes of the moons of Mars as viewed from the Curiosity rover!

Problem 1 – Earth's moon is located 370,000 km from the surface of earth, and has a diameter of 3476 km. About how many degrees across does the lunar disk appear in the sky?

Problem 2 - Deimos has a diameter of 7.5 miles (12 kilometers) and was 12,800 miles (20,500 kilometers) from the rover at the time of the image. Phobos has a diameter 14 miles (22 kilometers) and was 3,900 miles (6,240 kilometers) from the rover at the time of the image. What are the angular diameters of Phobos and Diemos as seen by the Curiosity rover?

Problem 3 – Mars is located 227 million kilometers from the sun, and the sun has a diameter of 1,400,000 kilometers. What is the angular diameter of the sun as viewed from Mars?

Problem 4 – Occasionally, Phobos and Diemos pass across the face of the sun as viewed from the surface of Mars. Will the moons create a full eclipse of the sun in the same way that Earth's moon covers the full face of the sun as viewed from Earth?

NASA Rover Gets Movie as a Mars Moon Passes Another
http://www.nasa.gov/mission_pages/msl/news/msl20130815.html
August 15, 2013

Problem 1 – Earth's moon is located 370,000 km from the surface of earth, and has a diameter of 3476 km. About how many degrees across does the lunar disk appear in the sky?

Answer: Apparent size = $57.3 \times (3476/370000) = \mathbf{0.5 \text{ degrees}}$.

Problem 2 - Deimos has a diameter of 7.5 miles (12 kilometers) and was 12,800 miles (20,500 kilometers) from the rover at the time of the image. Phobos has a diameter 14 miles (22 kilometers) and was 3,900 miles (6,240 kilometers) from the rover at the time of the image. What are the angular diameters of Phobos and Diemos as seen by the Curiosity rover?

Answer: Diemos: $57.3 \times (12/20500) = \mathbf{0.033 \text{ degrees}}$
Phobos: $57.3 \times (22/6240) = \mathbf{0.2 \text{ degrees}}$.

Note: Diemos appears to be about $.033/.2 = 1/6$ the diameter of Phobos in the sky.

Problem 3 – Mars is located 227 million kilometers from the sun, and the sun has a diameter of 1,400,000 kilometers. What is the angular diameter of the sun as viewed from Mars?

Answer: $57.3 \times (1400000/227,000,000) = 57.3 \times (1.4/227) = \mathbf{0.35 \text{ degrees}}$.

Problem 4 – Occasionally, Phobos and Diemos pass across the face of the sun as viewed from the surface of Mars. Will the moons create a full eclipse of the sun in the same way that Earth's moon covers the full face of the sun as viewed from Earth?

Answer: Diemos is only $0.033/0.35 = 1/11$ the diameter of the sun in the sky as viewed from Mars, so it does not cover the full disk of the sun. As it passes across the sun it would look like a large dark spot. Phobos is $0.2/0.35 = \frac{1}{2}$ the diameter of the sun in the sky and it would not produce an eclipse like our moon does. It would look like a large black spot $\frac{1}{2}$ the diameter of the sun.