



The High Resolution Imaging Science Experiment (HiRISE) camera on NASA's Mars Reconnaissance Orbiter acquired this image of the Opportunity rover on the southwest rim of "Santa Maria" crater on New Year's Eve 2010. Opportunity arrived at the western edge of Santa Maria crater in mid-December and will spend about two months investigating rocks there. That investigation will take Opportunity into the beginning of its eighth year on Mars. Opportunity is imaging the crater interior to better understand the geometry of rock layers and the meteor impact process on Mars. Santa Maria is a relatively young, 90 meter-diameter impact crater, but old enough to have collected sand dunes in its interior.

Problem 1 - Using a millimeter ruler, what is the scale of this image in meters per millimeter to one significant figure?

Problem 2 - To one significant figure, about what is the circumference of the rim of this crater in meters?

Problem 3 - The rover can travel about 100 meters in one day. To one significant figure, how long will it take the rover to travel once around this crater?

Problem 4 - A comfortable walking speed is about 100 meters per minute. To one significant figure, how long would it take a human to stroll around the edge of this crater?

Problem 1 - Using a millimeter ruler, what is the scale of this image in meters per millimeter to one significant figure?

Answer: The shape of the crater is irregular, but taking the average of several diameter measurements with a ruler gives a diameter of about 55 millimeters. Since this corresponds to 90 meters according to the text, the scale of this image is about $90 \text{ meters}/55 \text{ mm} = 1.8 \text{ meters/millimeter}$, which to one significant figure becomes **2 meters/millimeter**.

Problem 2 - To one significant figure, about what is the circumference of the rim of this crater in meters?

Answer: Students may use a piece of string and obtain an answer of about 200 millimeters. Using the scale of the image in Problem 1, the distance in meters is about $200 \text{ mm} \times 2 \text{ meters/mm} = \mathbf{400 \text{ meters}}$.

Problem 3 - The rover can travel about 100 meters in one day. To one significant figure, how long will it take the rover to travel once around this crater?

Answer: $400 \text{ meters} \times (1 \text{ day}/100 \text{ meters}) = \mathbf{4 \text{ days}}$.

Problem 4 - A comfortable walking speed is about 100 meters per minute. To one significant figure, how long would it take a human to stroll around the edge of this crater?

Answer: $400 \text{ meters} \times (1 \text{ minute}/100 \text{ meters}) = \mathbf{4 \text{ minutes}}$.