



The NASA, Lunar Reconnaissance Orbiter (LRO) satellite recently imaged the Apollo 11 landing area on the surface of the moon. The above (172 pixels wide x 171 pixels high) image shows this area and is 172 meters wide.

Problem 1 - Determine the scale of the image in meters per millimeter and meters per pixel? What is the diameter, in meters, of A) the largest crater? B) the smallest crater?

Problem 2 - The shadow near the center of the picture was cast by the Apollo-11 Lunar Landing Module and is about 3.5 meters tall. Using A) trigonometry, or a B) scaled drawing and a protractor, what was the sun angle at the time of the photograph?

Problem 1 - The image is 153 millimeters wide, which corresponds to 172 meters, so the scale is **1.1 meters per millimeter**, and the image is 172 pixels wide so the resolution is 172 pixels/153 meters = **1.1 meters/pixel**.

A) The largest crater is about 25mm x 30 mm in size, which corresponds to 25mm x 1.1 meters/mm = 28 meters wide, and 30 mm x 1.1 = 33 meters long, for an **average size of about 30 meters across**.

B) The smallest discernable features are about 1 to 2 mm wide, which corresponds to an actual size of about 1-2 pixels or **1 to 2 meters**.

Problem 2 - The shadow near the center of the picture was cast by the Lunar Landing Module which is about 3.5 meters tall. Using A) trigonometry, or a B) scaled drawing and a protractor, what was the sun angle at the time of the photograph?

Answer: The length of the shadow from the base of the Lander is about 23 millimeters or in actual length, 23 x 1.1 = 25 meters. This makes a right triangle, ABC, with a base length AB= 25 meters and an altitude of AC=3.5 meters and a hypotenuse located along BC, with the right-angle defined as ABC.

A) From trigonometry, $\tan(\theta) = 3.5 \text{ meters}/25 \text{ meters} = 0.14$ so the angle whose tangent is 0.14 is $\theta = 8.0 \text{ degrees}$. So the sun was 8 degrees above the horizon as viewed from the Lander.

B) A scaled drawing is shown below, and a protractor may be used to measure the angle ABC directly from the diagram.

