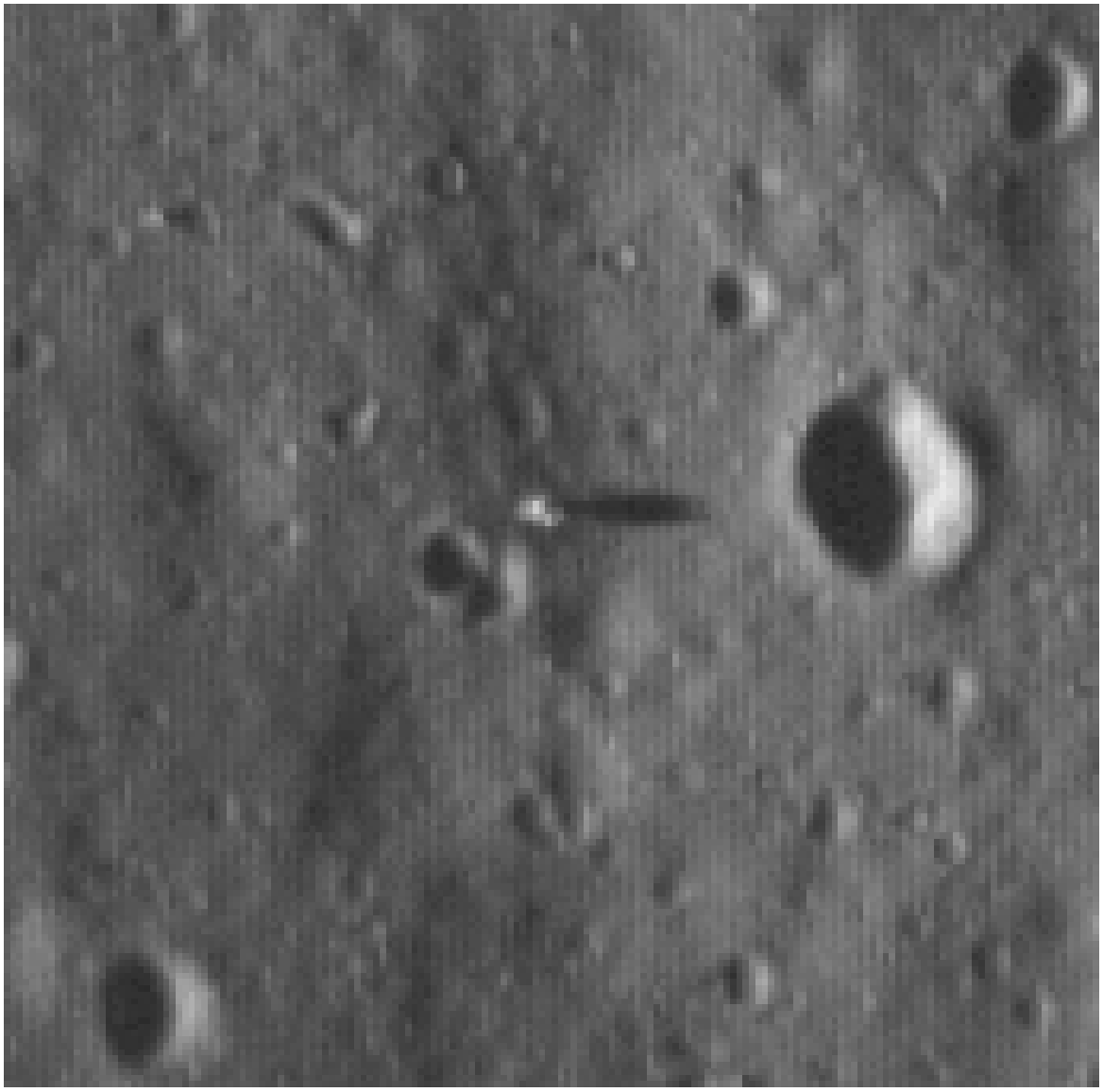

The LRO satellite recently imaged the Apollo 11 landing area on the surface of the moon. The above (172 pixels wide x 171 pixels high) image shows this area and is 172 meters wide.

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 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?

Problem 3 - Are there any individual boulders larger than 1 meter across in this area?

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?

Answer: 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.

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. Note, there can be no actual details smaller than the pixel resolution of the image (1.1 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.

Method 1: From trigonometry, Tan(theta) = 3.5 meters/25 meters = 0.14 so the angle whose tangent is 0.14 is theta=8.0 degrees.

Method 2: A scaled drawing is shown below, and a protractor may be used to measure the angle directly from the diagram.

Problem 3 - Are there any individual boulders larger than 1 meter across in this area?
Answer: No, because they would have shadows about 7 meters long (1/4 the Apollo 11 module) and there are no such shadows in the image, other than the Apollo-11 Landing Module itself. This area of the moon seems to be boulder-free at a resolution of 1 meter, which is why it was selected by Apollo-11 astronauts for a landing site.