



This is a NASA image taken by the Lunar Orbiter IV spacecraft as it captured close-up images of the lunar surface in May, 1967. The large crater at the top-center is Tycho. Other images from the Lunar Orbiter spacecrafts can be found at the Lunar Orbiter Photo Gallery (<http://www.lpi.usra.edu/resources/lunarorbiter/>) The satellite was at an altitude of 3,000 kilometers when it took this image, which measures 350 km x 270 km.

The scale of an image is found by measuring with a ruler the distance between two points on the image whose separation in physical units you know. In this case, we are told the field of view of the image is 350 kilometers x 270 kilometers.

Step 1: Measure the width of the lunar image with a metric ruler. How many millimeters long is the image?

Step 2: Read the explanation for the image and note any physical scale information provided. The information in the introduction says that the image is 350 kilometers along its largest dimension.

Step 3: Divide your answer to Step 2 by your answer to Step 1 to get the image scale in kilometers per millimeter to two significant figures.

Once you know the image scale, you can measure the size of any feature in the image in units of millimeters. Then multiply it by the image scale from Step 3 to get the actual size of the feature in kilometers to two significant figures.

Question 1: What is the diameter of the crater Tycho in kilometers?

Question 2: How large is the smallest feature you can see?

Question 3: How large are some of the smaller hills at the floor of the crater, in meters?

Question 4: About how large are the most common craters in the field?

Question 5: Which crater is about the same size as Denver, which has a diameter of about 25 km?

Step 1: Measure the width of the lunar image with a metric ruler. How many millimeters long is the image?
Answer: 150 millimeters.

Step 2: Read the explanation for the image and note any physical scale information provided. The information in the introduction says that the image is 350 kilometers along its largest dimension.
Answer: 350 kilometers.

Step 3: Divide your answer to Step 2 by your answer to Step 1 to get the image scale in kilometers per millimeter to two significant figures.
Answer: $350 \text{ kilometers} / 150 \text{ millimeters} = 2.3 \text{ kilometers} / \text{millimeter}$.

Once you know the image scale, you can measure the size of any feature in the image in units of millimeters. Then multiply it by the image scale from Step 3 to get the actual size of the feature in kilometers to two significant figures.

Question 1: What is the diameter of the crater Tycho in kilometers?

Answer: About 35 millimeters \times 2.3 km/mm = 80.5 kilometers in diameter which is 80 kilometers to two significant figures.

Question 2: How large is the smallest feature you can see?

Answer: There are many small details in the image, pits, hills, etc, that students can estimate 0.1 to 0.3 millimeters for a physical size of 0.2 to 0.7 kilometers since the measurement is only good to one significant figure.

Question 3: How large are some of the smaller hills at the floor of the crater, in meters?

Answer: These small features are about 0.1 millimeters across or 200 meters in size.

Question 4: About how large are the most common craters in the field?

Answer: The answer may vary a bit, but the small craters that are 0.5 millimeters across are the most common. These have a physical size of about 1 kilometer.

Question 5: Which crater is about the same size as Denver, which has a diameter of about 25 km?

Answer: In order to fit Denver into one of these lunar craters, it will have to appear to be about $25 \text{ km} \times (1.0 \text{ millimeter} / 2.3 \text{ km}) = 11 \text{ millimeters}$ across. There are three craters just to the right of Tycho that are about this big. Students should not get 'lost' trying to exactly match up their estimate with a precise lunar feature. 'Close-enough' estimates are good enough! See below comparison as a guide.

