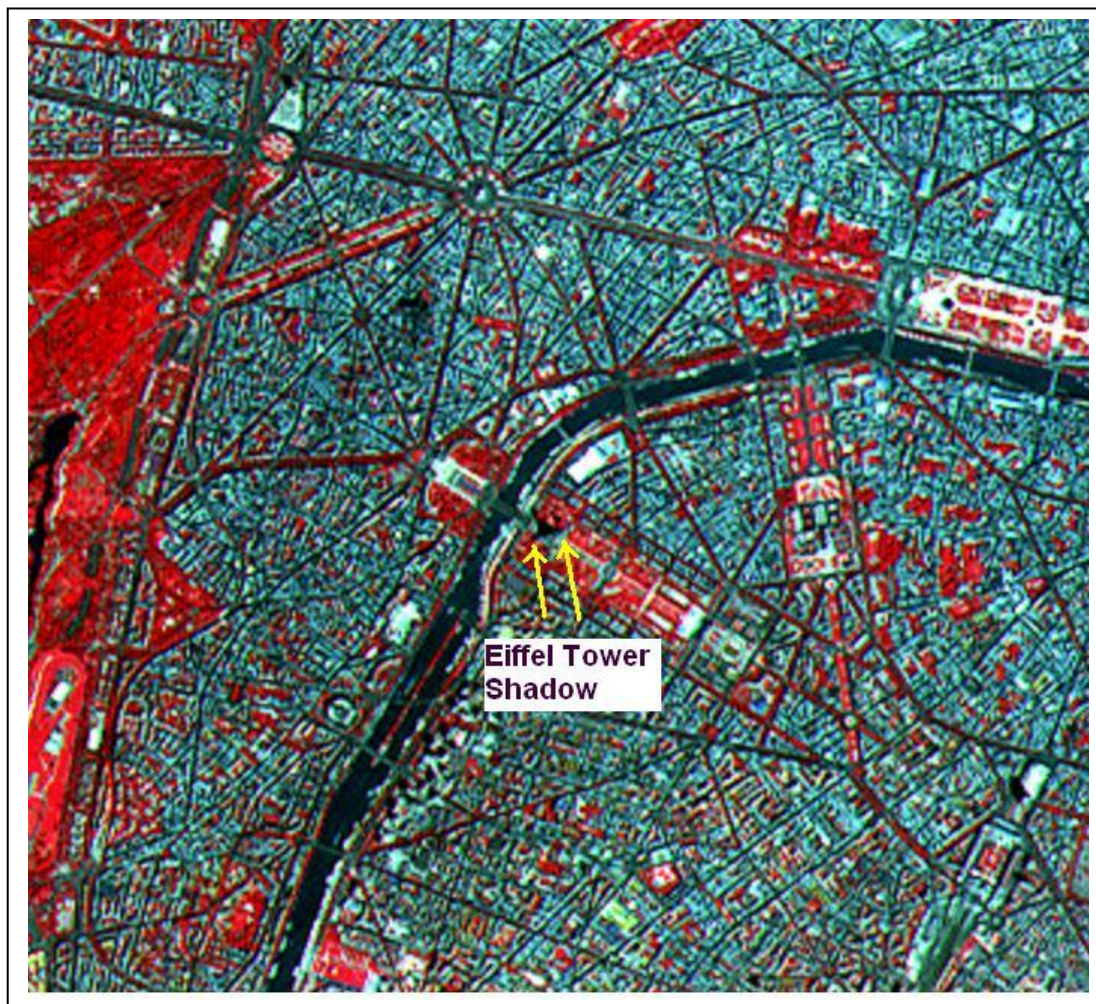


The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is one of five Earth-observing instruments launched December 18, 1999, on NASA's Terra satellite (<http://modis.gsfc.nasa.gov/gallery/>). The infrared image below is of Paris taken on July 23, 2000. The famous Seine River snakes through the image from left to right, and appears black because water is colder than the surrounding landscape. Vegetation appears red and buildings appear blue-gray because of the color-coding that was used to represent warm (red) and cold (blue) areas.



**Problem 1** - This image is 5.6 kilometers wide. Using a metric ruler, what is the scale of the image in meters/mm?

**Problem 2** - What is the width, in meters, of; A) The Seine River? B) The traffic circle (Arc de Triomphe)

**Problem 3** - The shadow of the Eiffel Tower can be seen as the triangular spot between the two arrows. Measure the length of the shadow indicated by the arrows, and from the solar elevation angle of 60 degrees at the time of the photograph. Create a scaled drawing of the tower, the shadow and the solar angle. A) From your drawing, what is the height of the Eiffel Tower in meters? B) At what sun angle would the shadow be 311 meters long?

## Answer Key

**Problem 1** - This image is 5.6 kilometers wide. Using a metric ruler, what is the scale of the image in meters/mm? **Answer: The width is 140 mm, so the scale is  $5600/140 = 40$  meters/mm.**

Problem 2 - What is the width, in meters, of

A) the Seine River? **Answer: About 5 mm or 200 meters.**

B) The traffic circle (Arc de Triomphe) **Answer: About 7mm or 280 meters.**

**Problem 3** - The shadow of the Eiffel Tower can be seen in this ASTER image as the triangular spot between the two arrows. Measure the length of the shadow indicated by the arrows, and from the solar elevation angle of 60 degrees at the time of the photograph. Create a scaled drawing of the tower, the shadow and the solar angle. A) From your drawing, what is the height of the Eiffel Tower in meters? B) At what sun angle would the shadow be 311 meters long?

**Answer: A) The sketch below gives this information. The length of the shadow is about 4.5 mm or 180 meters. Students may carefully draw a scaled triangle using  $1\text{cm} = 10$  meters, so that the shadow (base of triangle) is 18cm long. The hypotenuse will then be  $180\text{m} \times (2) = 360$  meters or 36 cm. The vertical side, which is the height of the Eiffel Tower will be  $180\text{m} \times (3)^{1/2} = 180\text{m} \times 1.732 = 311$  meters. The actual height of the Eiffel Tower is 300 meters to the roof and 320 meters including the radio spire at its top, so the student's estimate from the shadow length is reasonably accurate, given the resolution of the photo.**

**B) Answer: If the height of the tower is the same as the shadow length, the angle must be 45 degrees.**

The photograph below shows a more familiar view of this historic structure. (Courtesy FreeDigitalPhotos.net)

