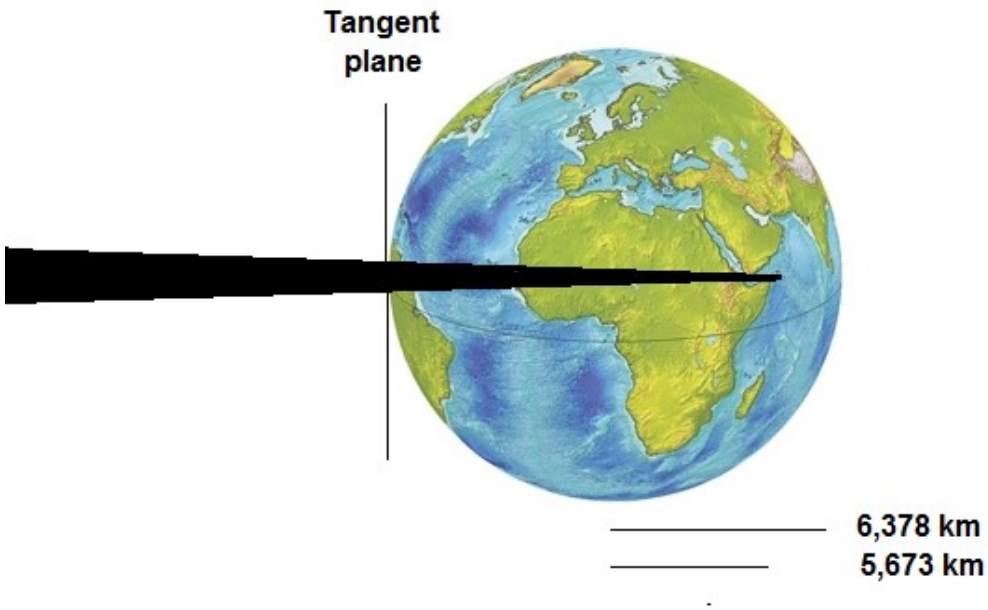
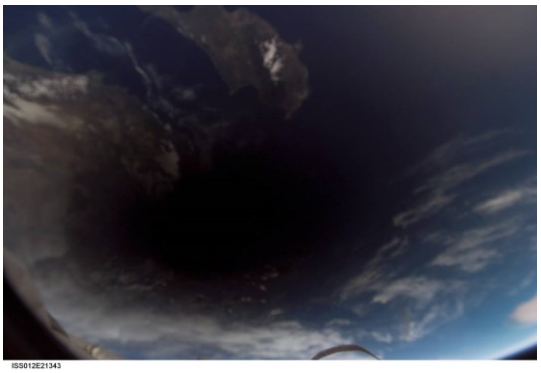
Lunar Shadow Size on Earth's Surface

The center-to-center distance between Earth and moon is 372,027 kilometers, and the distance of the vertex of the shadow cone from the center of the moon is 377,700 km. That means that the vertex lies below the daytime surface of Earth and stretches 377,700 – 372,027 = 5673 km beyond the center of Earth. It is also 705 km below the surface of Earth diametrically opposite the daytime position of totality.





What this means is that the shadow of the moon on Earth's daytime surface is a disk of darkness, and not a mathematical point, that traverses the path of totality. This has been seen in many photos taken from space of total solar eclipses such as this one obtained from the International Space Station on March 29, 2006 by the Expedition 12 crew.

We can calculate the radius of moon shadow on the Earth's surface over North America from the radius of the moon (1737 km) and by invoking a simple proportion:

$$\frac{\text{Lunar radius}}{\text{Shadow cone length}} = \frac{H}{(\text{cone length-earthmoon distance}) + \text{earth radius}}$$

$$H = \frac{(5673+6378)\ 1737}{377{,}700} = 55 \text{ km radius or } 110 \text{ km diameter}$$

A detailed calculation at the Greatest Eclipse location near Carbondale, Illinois gives a diameter of about 114 km diameter.

Problem 1 – The diameter is about 110 km, so it will take 110 km / (2600 k/h) = 0.042 hours or about 2.5 minutes from start to finish. After that time, the limb of the sun will brighten enormously and darkness will become daylight again. This does not leave much time for photographers to set up their equipment correctly and snap a few pictures!

Problem 2 - H = (8186-9300 + 3396) 12.5 / 8186 = 3.5 km
The angular diameter of Phobos would appear to be significantly smaller than the sun so there would be no total solar eclipse.