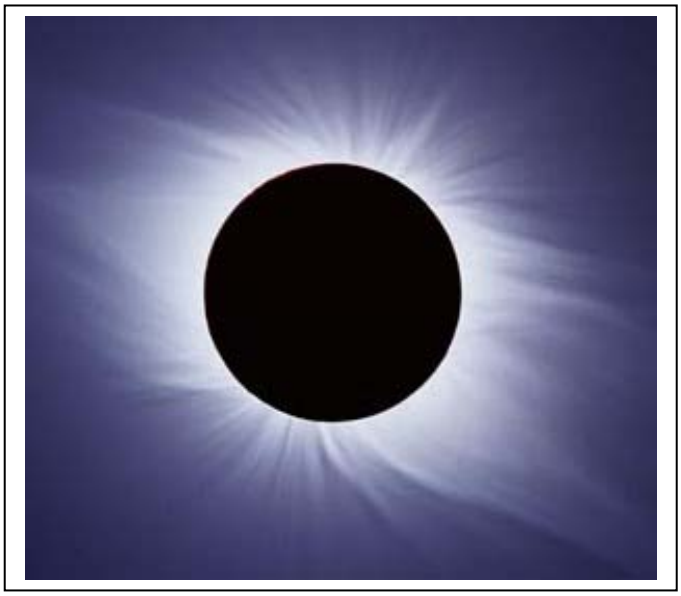
The Last Total Solar Eclipse...Ever!



Total solar eclipses happen because the angular size of the moon is almost exactly the same as the sun's, despite their vastly different distances and sizes.

The moon has been steadily pulling away from earth over the span of billions of years. There will eventually come a time when these two angular sizes no longer match up. The moon will be too small to cause a total solar eclipse.

When will that happen?

Image courtesy Fred Espenak
http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html

Problem 1 - The minimum distance to the moon, called the perigee, is 356,400 kilometers. At that distance, the angular size of the moon from the surface of Earth is 0.559 degrees. Suppose you doubled the distance to the moon. What would its new angular size be, as seen from the surface of Earth?

Problem 2 - Suppose you increased the moon's distance by 50,000 kilometers. What would the angular size now be?

Problem 3 - The smallest angular size of the sun occurs near the summer solstice at a distance of 152 million kilometers, when the sun has an angular diameter of 0.525 degrees. How far away, in kilometers, does the moon have to be to match the sun's apparent diameter?

Problem 4 - How much further away from Earth will the moon be at that time?

Problem 5 - The moon is moving away from Earth at a rate of 3 centimeters per year. How many years will it take to move 3 kilometer further away?

Problem 6 - How many years will it take to move the distance from your answer to Problem 4?

Problem 7 - When will the last Total Solar Eclipse be sighted in the future?

Answer Key:

Problem 1 - The minimum distance to the moon, called the perigee, is 356,400 kilometers. At that distance, the angular size of the moon from the surface of Earth is 0.559 degrees. Suppose you doubled the distance to the moon. What would its new angular size be, as seen from the surface of Earth?

Answer: Because objects appear smaller the farther away they are, if you double the distance, the moon will appear half its former size, or 0.559/2 = 0.279 degrees across.

Problem 2 - Suppose you increased the moon's distance by 50,000 kilometers. What would the angular size now be?

Answer: The distance is now 356,400 kilometers + 50,000 kilometers = 406,400 kilometers. The distance has increased by 406,400/356,400 = 1.14, so that means that the angular size has been reduced to 0.559 / 1.14 = 0.49 degrees.

Problem 3 - The smallest angular size of the sun occurs near the summer solstice at a distance of 152 million kilometers, when the sun has an angular diameter of 0.525 degrees. How far away, in kilometers, does the moon have to be to match the sun's apparent diameter?

Answer: 0.559/0.525 = 1.06 times further away from Earth or 356,400 km x 1.06 = 377,800 kilometers.

Problem 4 - How much further away from Earth will the moon be at that time?

Answer: 377,800 kilometers - 356,400 kilometers = 21,400 kilometers.

Problem 5 - The moon is moving away from Earth at a rate of 3 centimeters per year. How many years will it take to move 3 kilometer further away?

Answer: (300,000 centimeters) / (3 centimeters / year) = 100,000 years.

Problem 6 - How many years will it take to move the distance from your answer to Problem 4?

Answer: (21,400 kilometers / 3 kilometers) x 100,000 years = 713 million years.

Problem 7 - When will the last Total Solar Eclipse be sighted in the future?

Answer: About 713 million years from now.