Ancient Eclipses and the Length of the Day



Astronomers can use sophisticated mathematical models to accurately predict when eclipses occurred anywhere on Earth as long ago as 10,000 years. But to achieve this, the models must account for the length of the day being shorter than it is today! The above figure (right) shows the track of the total solar eclipse of April 15, 136 BC recorded on cuneiform tablets by Babylonian astronomers. The figure (left) also shows the predicted track without allowing for the different length of day back in 136 BC!

**Problem 1** - At the latitude of Babylon, the computed track crosses at a longitude of +4.3 West. The actual longitude of Babylon is +44.5 East. By how many degrees in longitude does the computed track miss Babylon?

**Problem 2** - How long does it take Earth, in seconds, to rotate through the longitude difference in Problem 1?

**Problem 3** - To calculate the rate, R, at which the day is lengthening in milliseconds per century, geologists use the formula T = 18 R t2. If T is your answer to Problem 2, and t is the number of centuries between 136 BC and today, what is R?

**Problem 4** - Based on your answer for R, what will be the length-of-day in 100 million years from now expressed in decimal hours?

Answer Key 7

 **roblem 1** - At the latitude of Babylon, the computed track crosses at a longitude of

+4.3 West. The actual longitude of Babylon is +44.5 East. By how many degrees in longitude does the computed track miss Babylon? Answer; 44.3 + 4.3 = 48.8 degrees.

**Problem 2** - How long does it take Earth, in seconds, to rotate through the longitude difference in Problem 1? Answer: In 24 hours it rotates through 360 degrees in longitude, so to rotate 48.8 degrees it will take 24 hours x (48.8 / 360) = 3.25 hours, and so 3.25 hrs x (3600 sec/1 hour) = 11,700 seconds.

**Problem 3** - To calculate the rate, R, at which the day is lengthening in milliseconds per century, geologists use the formula T = 18 R t2. If T is your answer to Problem 2, and t is the number of centuries between 136 BC and today, what is R?

Answer: T = 11,700 seconds

t = (2008 + 136)/100 = 21.4 centuries (note there was no Year-Zero!) solve the equation for R to get R = T/18t2 and so R = (11,700) / (18 x 21.42 )

R = 1.4 milliseconds/century

**Problem 4** - Based on your answer for R, what will be the length-of-day in 100 million years from now expressed in decimal hours?

Answer: In 100 million years there are 1 million centuries, so 1 million centuries x 1.4 milliseconds/century x (0.001 seconds/millisecond) = 1400 seconds. Since there are 3600 seconds in 1 hour, the new 'day' will be 24 hours + 1400/3600 hours = 24 + 0.39 hours = 24.39 hours long.

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