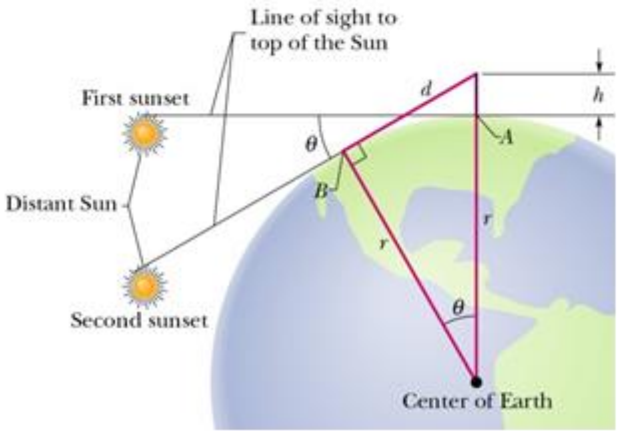
Answer on Question #64452-Physics-Classical Mechanics

While lying on the beach near the equator watching the sun set over a calm ocean, you start a stopwatch just as the top of the sun disappears. You then stand elevating your eyes by a height of 1.70 m and see the sun again. You stop the watch when the top of the sun disappears again. If the elapsed time is 5.74 s, what is the radius of the earth?

Solution

When the Sun first disappears while lying down, your line of sight to the top of the Sun is tangent to the Earth's surface at point A shown in the figure. As you stand, elevating your eyes by a height h, the line of sight to the Sun is tangent to the Earth's surface at point B.



Let *d* be the distance from point B to your eyes. From Pythagorean Theorem, we have

$$d^2 + r^2 = (r + h)^2 = r^2 + 2rh + h^2$$

or $d^2 = 2rh + h^2$ where *r* is the radius of the Earth. Since $r \gg h$, the second term can be dropped, leading to $d^2 \approx 2rh$. Now the angle between the two radii to the two tangent points *A* and *B* is θ, which is also the angle through which the Sun moves about Earth during the time interval *t* = 5.74 s. The value of θ can be obtained by using

$$\frac{\theta}{360°} = \frac{t}{24\,h}$$

This yields

$$\theta = \frac{(360°)(5.74\text{ s})}{(24\,h)\left(60\frac{min}{h}\right)\left(60\frac{s}{min}\right)} = 0.02392°$$

Using $d = r\tan\theta$, we have $d^2 = r^2\tan^2\theta = 2rh$, or

$$r = \frac{2h}{\tan^2\theta} = \frac{2\cdot 1.70}{\tan^2 0.02392°} = 19.5\cdot 10^6\ m.$$

Answer provided by https://www.AssignmentExpert.com