Radius of Earth

There is a simple experiment where anyone of us can use to estimate the radius of the living earth. Start by lying on the beach where one can see the sunset. The moment the sun touches sea level, which is, called the first sunset, stand up, start the stopwatch and watch the sun. The next moment the sun touches the sea level, which called the second sunset, stops the stopwatch and notes the time lapped.

The radius of the earth can be estimated by the simple theory. From Fig. 1, h is the height of a person, r is the radius of the earth, t is the time interval between two sunsets, and θ is angle of rotation of the earth between two sunsets.

By Pythagoras theorem,

\[ d^2 + r^2 = (r + h)^2 = r^2 + 2rh + h^2 \]  

(1)

2rh >> h^2, therefore,

\[ d^2 = 2rh \]  

(2)

Also,

\[ \frac{\theta}{360^\circ} = \frac{t}{24\text{hr}} \]  

(3)

and
\[ \tan \theta = \frac{r}{d} \] \hspace{1cm} (4)

Implying,
\[ d = r \tan \theta \] \hspace{1cm} (5)

From equation (2) and equation (5)
\[ 2rh = r^2 \tan^2 \theta \] \hspace{1cm} (6)

Implying that
\[ r = \frac{2h}{\tan^2 \theta} \] \hspace{1cm} (7)

Substitute equation (3) into equation (7), the radius \( r \) of the earth is
\[ r = \frac{2h}{\tan^2 \left( \frac{360^\circ \cdot t}{24 \text{hr}} \right)} \] \hspace{1cm} (8)

If your height \( h \) at eye level is 5ft and the time interval \( t \) between two sunsets is 9.9 seconds, then the radius \( r \) of the earth is estimated to be 3,654 miles. This number is very close to the actual radius of the earth at equator which is 3,965 miles.

To improve the estimation, many experiments can be made with several persons or with a taller object.