Find % correction needed to account for the signal delay due to the earth's atmosphere.

$d_{em} = 3.84 \times 10^{8}$ m

$h_{atm} = 30.0 \times 10^{3}$ m $\quad n_{atm} = 1.000293$

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assuming no atmospheric effect, the time for the signal to go to the moon back to the earth is

$$\Delta x = v \cdot \Delta t \quad \rightarrow \quad \Delta x = 2 \cdot d_{em}$$

$$\therefore \Delta t = \frac{\Delta x}{v} = \frac{2\,d_{em}}{v} = \frac{2(3.84 \times 10^{8}\,m)}{3.00 \times 10^{8}\,m/s}$$

$$\Delta t = 2.56\,s$$

Going through the atmosphere both ways takes

$$\Delta t_{atm} = \frac{2 \cdot \Delta x_{atm}}{v} = \frac{2(30 \times 10^{3}\,m)}{3.00 \times 10^{8}\,m/s} = 2.0 \times 10^{-4}\,s$$

This is if there is no change in the speed of light. However, in the atmosphere,

$$n = \frac{c}{v} \qquad v = \frac{c}{n} = \frac{3.0 \times 10^{8}\,m/s}{1.000293} = 2.9991 \times 10^{8}\,m/s$$

and the time through the atmosphere is

$$\Delta t_{atm\,true} = \frac{2(30. \times 10^{3}\,m)}{2.9991 \times 10^{8}\,m/s} = 2.0006 \times 10^{-4}\,s$$

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$\therefore$ The additional time for the round trip due to the atmosphere is

$$\Delta t_{\substack{atm\\true}} - \Delta t_{atm} = 2.0006\times10^{-4}s - 2.0000\times10^{-4}s = 0.0006\times10^{-4}$$
$$= 6.0\times10^{-8}s$$

% correction is this delay divided by the round trip time of the signal $\times 100\%$

$$\%\,delay = \frac{6.0\times10^{-8}s}{2.56s}\times100\% = \boxed{2.34\times10^{-6}\%}$$

Not taking the atmosphere into account results in an error of 2 millionths of a percent. This doesn't seem like much, but over a distance of $3.84\times10^{8}m$, you could be off by 9m

$$X_{error} = d_{em}\times\frac{\%\,delay}{100\%} = 3.84\times10^{8}m\,\frac{(2.34\times10^{-6}\%)}{100\%}$$

$$X_{error} = 8.99m$$