(a) Fastest ray travels straight
down the center, and travel distance \( d \)
ine time \( t_1 = \frac{d}{v} = \frac{d}{(c/n_1)} = \frac{d}{c} \).

Slower ray zig-zags down at steepest angle, namely, right
To travel horizontal distance \( L \), you must travel actual distance \( h \). Time to go \( h \) is \( t_2 = \frac{h}{(c/n_2)} = \frac{h}{c} \).

But since \( \sin \theta = \frac{h}{d} \), \( t_2 = \frac{h}{c \sin \theta} \).

From Snell's law \( \sin \theta = n_2/n_1 \), so \( t_2 = \frac{d}{c \sin \theta} = \frac{n_2 d}{c} = \frac{n_2}{c} \frac{d}{n_1} (n_1 - n_2) \).

Since \( \theta \) is the difference in refraction in \( \theta \), for total fiber
\( \Delta t = \frac{L}{c} \frac{n_2}{n_1} (n_1 - n_2) \).

(b) \( n_1 = 1.58, \ n_2 = 1.53, \ L = 300 \text{ m} \)

\[ \Delta t = \frac{300}{c} \frac{1.58}{1.53} (1.58 - 1.53) \]

\[ \Delta t = 5.16 \times 10^{-8} \text{ s} \]

(Fibers like this are known as "multimode" fibers.
They cannot be used for high speed data transmission because
the "modal dispersion" is outlined above. Hence, the frequencies
of attenuation to \( n_2/\Delta t \) which would be only 2 MHz for a
2 km fiber like this are above. Modern communication
systems use single mode fibers and 50 GHz frequency.)