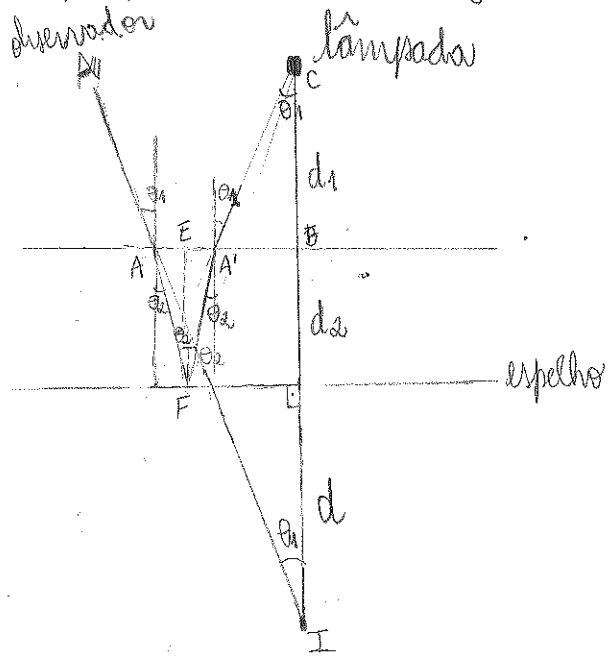
Ex 5, pág 63, Halliday - cap 34



$n_1 = n_{ar} = 1$

$n_2 = n_{água} = 1{,}33$

$d_1 = 250\ cm$

$d_2 = 200\ cm$

Lei de Snell

$$\begin{cases} n_1 . \operatorname{sen}\theta_1 = n_2 . \operatorname{sen}\theta_2 \\ \tan\theta_1 = \dfrac{AB}{d + d_2} \quad (\text{triângulo } ABI) \\ \tan\theta_1 = \dfrac{A'B}{d_1} \quad (\text{triângulo } A'BC) \\ \tan\theta_2 = \dfrac{AA'/2}{d_2} \quad (\text{triângulo } AEF) \\ AA' + A'B = AB \end{cases}$$

com as aproximações para pequenos ângulos

$$\begin{cases} n_1 . \theta_1 = n_2 . \theta_2 \quad (I) \\ \theta_1 = \dfrac{AB}{d + d_2} \quad (II) \\ \theta_1 = \dfrac{A'B}{d_1} \quad (III) \\ \theta_2 = \dfrac{AA'}{2d_2} \quad (IV) \\ AA' + A'B = AB \quad (V) \end{cases}$$

De (II), (III) e (IV):

$AB = \theta_1 (d + d_2)$

$A'B = d_1 . \theta_1$

$AA' = 2d_2 . \theta_2$

Substituindo em (V):

$2d_2 . \theta_2 + d_1 \theta_1 = \theta_1 (d + d_2)$

$2d_2 \dfrac{\theta_2}{\theta_1} + d_1 = d + d_2$

$d = 2d_2 \dfrac{\theta_2}{\theta_1} + d_1 - d_2 \quad (VI)$

De (I):

$\dfrac{\theta_2}{\theta_1} = \dfrac{n_1}{n_2}$

Substituindo em (VI):

$d = 2d_2 \dfrac{n_1}{n_2} + d_1 - d_2$

$d = 2.200 \dfrac{1}{1{,}33} + 250 - 200 = 351\ cm$