

22.61. Model: An interferometer produces a new maximum each time L_2 increases by $\frac{1}{2}\lambda$ causing the path-length difference Δr to increase by λ .

Visualize: Please refer to the interferometer in Figure 22.20.

Solve: The path-length difference between the two waves is $\Delta r = 2L_2 - 2L_1$. The condition for constructive interference is $\Delta r = m\lambda$, hence constructive interference occurs when

$$2(L_2 - L_1) = m\lambda \Rightarrow L_2 - L_1 = \frac{1}{2}m\lambda = 1200\left(\frac{1}{2}\lambda\right) = 600\lambda$$

where $\lambda = 632.8$ nm is the wavelength of the helium-neon laser. When the mirror M_2 is moved back and a hydrogen discharge lamp is used, 1200 fringes shift again. Thus,

$$L'_2 - L_1 = 1200\left(\frac{1}{2}\lambda'\right) = 600\lambda'$$

where $\lambda' = 656.5$ nm. Subtracting the two equations,

$$(L_2 - L_1) - (L'_2 - L_1) = 600(\lambda - \lambda') = 600(632.8 \times 10^{-9} \text{ m} - 656.5 \times 10^{-9} \text{ m})$$

$$\Rightarrow L'_2 = L_2 + 14.2 \times 10^{-6} \text{ m}$$

That is, M_2 is now $14.2 \mu\text{m}$ closer to the beam splitter.