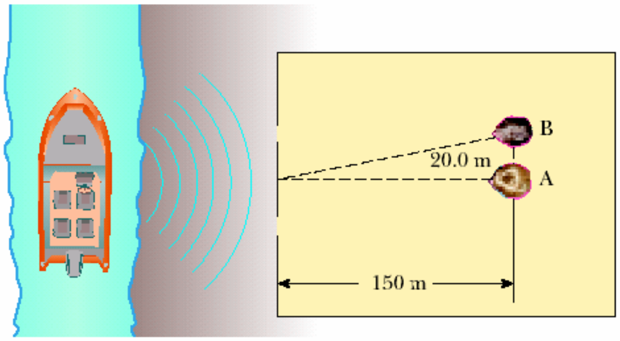
9. A riverside warehouse has two open doors as shown in Figure P37.9. Its walls are lined with sound-absorbing material. A boat on the river sounds its horn. To person A the sound is loud and clear. To person B the sound is barely audible. The principal wavelength of the sound waves is 3.00 m. Assuming person B is at the position of the first minimum, determine the distance between the doors, center to center.



P37.9 Location of $A =$ central maximum,

Location of $B =$ first minimum.

So, $\Delta y = [y_{min} - y_{max}] = \frac{\lambda L}{d}\left(0 + \frac{1}{2}\right) - 0 = \frac{1}{2}\frac{\lambda L}{d} = 20.0\text{ m}$.

Thus, $d = \frac{\lambda L}{2(20.0\text{ m})} = \frac{(3.00\text{ m})(150\text{ m})}{40.0\text{ m}} = \boxed{11.3\text{ m}}$.

18. Two slits are separated by 0.180 mm. An interference pattern is formed on a screen 80.0 cm away by 656.3-nm light. Calculate the fraction of the maximum intensity 0.600 cm above the central maximum.

P37.18 $I = I_{max}\cos^2\left(\frac{\pi yd}{\lambda L}\right)$

$$\frac{I}{I_{max}} = \cos^2\left[\frac{\pi(6.00\times10^{-3}\text{ m})(1.80\times10^{-4}\text{ m})}{(656.3\times10^{-9}\text{ m})(0.800\text{ m})}\right] = \boxed{0.968}$$

32. A thin film of oil (n = 1.25) is located on a smooth wet pavement. When viewed perpendicular to the pavement, the film reflects most strongly red light at 640 nm and reflects no blue light at 512 nm. How thick is the oil film?

P37.32 Since $1 < 1.25 < 1.33$, light reflected both from the top and from the bottom surface of the oil suffers phase reversal.

For constructive interference we require

$$2t = \frac{m\lambda_{\text{cons}}}{n}$$

and for destructive interference,

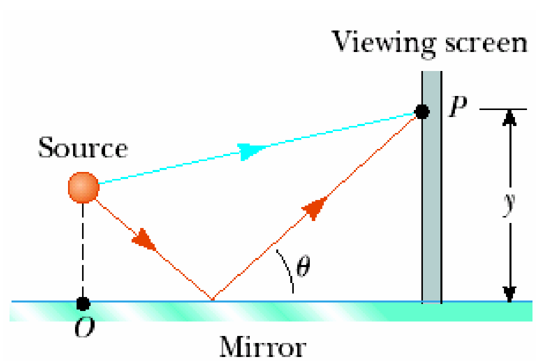
$$2t = \frac{\left[m + (1/2)\right]\lambda_{\text{des}}}{n}.$$

Then $\frac{\lambda_{\text{cons}}}{\lambda_{\text{dest}}} = 1 + \frac{1}{2m} = \frac{640\text{ nm}}{512\text{ nm}} = 1.25$ and $m = 2$.

Therefore,

$$t = \frac{2(640\text{ nm})}{2(1.25)} = \boxed{512\text{ nm}}.$$

52. Interference effects are produced at point P on a screen as a result of direct rays from a 500-nm source and reflected rays from the mirror, as shown in Figure P37.52. Assume the source is 100 m to the left of the screen and 1.00 cm above the mirror. Find the distance y to the first dark band above the mirror.



P37.52 For destructive interference, the path length must differ by $m\lambda$. We may treat this problem as a double slit experiment if we remember the light undergoes a $\frac{\pi}{2}$-phase shift at the mirror. The second slit is the mirror image of the source, 1.00 cm below the mirror plane. Modifying Equation 37.5,

$$y_{\text{dark}} = \frac{m\lambda L}{d} = \frac{1(5.00 \times 10^{-7}\text{ m})(100\text{ m})}{(2.00 \times 10^{-2}\text{ m})} = \boxed{2.50\text{ mm}}.$$

54. Many cells are transparent and colorless. Structures of great interest in biology and medicine can be practically invisible to ordinary microscopy. An *interference microscope* reveals a difference in refractive index as a shift in interference fringes, to indicate the size and shape of cell structures. The idea is exemplified in the following problem: An air wedge is formed between two glass plates in contact along one edge and slightly separated at the opposite edge. When the plates are illuminated with monochromatic light from above, the reflected light has 85 dark fringes. Calculate the number of dark fringes that appear if water ($n = 1.33$) replaces the air between the plates.

P37.54 For dark fringes, $2nt = m\lambda$

and at the edge of the wedge, $t = \dfrac{84(500\text{ nm})}{2}$.

When submerged in water, $2nt = m\lambda$

$$m = \frac{2(1.33)(42)(500\text{ nm})}{500\text{ nm}}$$

so $m + 1 = \boxed{113\text{ dark fringes}}$.

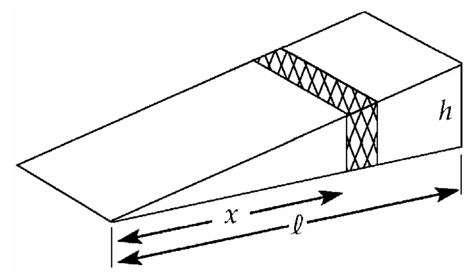


FIG. P37.54