1. Two radio antennas separated by \( d = 273 \) m, as shown in Figure P37.3 simultaneously broadcast identical signals at the same wavelength. A radio in a car traveling due north receives the signals.

(a) If the car is at the position of the second maximum, what is the wavelength of the signals?

\[ \frac{50.35}{124} \text{ m} \]

(b) How much farther must the car travel to encounter the next minimum in reception? (Note: Do not use the small-angle approximation in this problem.)

\[
2\lambda = \sqrt{1000^2 + (400 + \frac{273}{2})^2} - \sqrt{1000^2 + (400 - \frac{273}{2})^2}
\]

\[
= 1134.82 - 1034.134
\]

\[
= 100.687
\]

So, \( \lambda = 50.35 \) m.

\[
\frac{5}{2} \lambda
\]

\[
\Rightarrow \lambda = 124 \text{ m.}
\]
2. PSE6 37.P.007 [318009] Two narrow, parallel slits separated by 0.205 mm are illuminated by green light (\( \lambda = 546.1 \) nm). The interference pattern is observed on a screen 1.50 m away from the plane of the slits.

(a) Calculate the distance from the central maximum to the first bright region on either side of the central maximum.

\[
\sqrt{\frac{4 \lambda L}{d}} = \frac{546.1 \times 10^{-6} \times 1.5 \times 10^3}{0.205} \text{ mm}
\]

\[
= 4.0 \text{ mm}
\]

(b) Calculate the distance between the first and second dark bands.

\[
\Delta y_{\text{dark}} = \frac{\lambda L}{d} \left( 2 + \frac{1}{2} \right) - \frac{\lambda L}{d} \left( 1 + \frac{1}{2} \right) = \frac{\lambda L}{d} = 4.0 \text{ mm}
\]

3. PSE6 37.P.037 [318007] A beam of 460 nm light passes through two closely spaced glass plates, as shown in Figure P37.37. For what minimum nonzero value of the plate separation \( d \) is the transmitted light bright?

\[
2.30 \text{ nm}
\]

Figure P37.37

\[2d = m \lambda, \quad m = 1, 2, \ldots\]

\[d = \frac{m \lambda}{2}\]

\[d_{\text{min}} = \frac{\lambda}{2} = 230 \text{ nm}\]
4. A possible means for making an airplane invisible to radar is to coat the plane with an antireflective polymer. If radar waves have a wavelength of 3.20 cm and the index of refraction of the polymer is \( n = 1.70 \), how thick would you make the coating? (Assume that the index of refraction of the plane is higher than that of the coating.)

\[
\frac{\lambda}{2} = 2d \times 1.70
\]

So,

\[
d = \frac{\lambda}{4 \times 1.70} = \frac{3.20}{4 \times 1.70} = 0.471 \text{ cm}
\]

5. Two coherent waves are described by the expressions below, where \( a = 8 \) and \( b = 10 \).

\[
E_1 = E_0 \sin\left(\frac{2\pi x_1}{\lambda} - 2\pi f t + \frac{\pi}{a}\right)
\]

\[
E_2 = E_0 \sin\left(\frac{2\pi x_2}{\lambda} - 2\pi f t + \frac{\pi}{b}\right)
\]

Determine the relationship between \( x_1 \) and \( x_2 \) that produces constructive interference when the two waves are superposed. (Use \( m \) for \( m \) and \( \lambda \) for \( \lambda \).)

\[
x_1 - x_2 = \left(\frac{\lambda}{2}\right) m \text{ for } m = 0, 1, 2, 3, \ldots
\]

\[
\frac{2 \pi x_1}{\lambda} - \frac{2 \pi f t + \frac{2\pi}{a}}{2 \pi} = \frac{2 \pi x_2}{\lambda} - \frac{2 \pi f t + \frac{2\pi}{b}}{2 \pi} + 2\pi m
\]

\[
\rightarrow \frac{x_1}{\lambda} - \frac{x_2}{\lambda} = m + \frac{1}{2\pi} - \frac{1}{2\pi} b
\]

\[
\rightarrow x_1 - x_2 = (m + \frac{1}{2\pi} - \frac{1}{2\pi} b) \lambda
\]