Problem 1
In a two-slit interference experiment, the slits are 0.20 mm apart, and the screen is at a distance of 1.0 m. The third bright fringe (not counting the central bright fringe straight ahead from the slits) is found to be placed 7.5 mm from the central fringe. Find the wavelength of the light used.

\[ \text{The 3rd bright fringe corresponds to } m = 3 \]

\[ \gamma_{\text{bright}} = \frac{m \lambda L}{d} \Rightarrow \lambda = \frac{\gamma_{\text{bright}} d}{mL} \]

\[ d = 0.2 \times 10^{-3} \text{ m} \]

\[ L = 1 \text{ m} \]

\[ \Rightarrow \lambda = \frac{(7.5 \times 10^{-3} \text{ m})(0.2 \times 10^{-3} \text{ m})}{3(1.0 \text{ m})} = 500 \text{ nm} \]

Problem 2
Suppose the two glass plates in the figure below are two microscope slides 10 cm long. At one end they are in contact; at the other end they are separated by a piece of paper 0.020 mm thick. What is the spacing of the interference fringes seen by reflection? Is the fringe at the line of contact bright or dark? Assume monochromatic light with a wavelength in air of \( \lambda_0 = 500 \text{ nm} \).

Consider only interference between the light reflected from the upper and lower surfaces of the air wedge. The wave reflected from the lower surface has a 180° phase shift; the wave from the upper surface has none. Thus the fringe at the line of contact is [dark].

\[ 2t = m \lambda \quad m = 0, 1, 2, \ldots \]

Using similar triangles \( \frac{t}{x} = \frac{h}{L} \)

\[ \Rightarrow \frac{2xh}{L} = m \lambda_0 \quad \Rightarrow \quad x = m \frac{h \lambda_0}{2h} = m \frac{(1.0 \text{ m})(500 \times 10^{-9} \text{ m})}{2(0.020 \times 10^{-3} \text{ m})} = m (1.25 \text{ mm}) \]

\[ \Rightarrow \text{So the fringes are } 1.25 \text{ mm apart} \]
Problem 3
White light spans the wavelength range between about 400 nm and 700 nm. If white light passes through two slits 0.30 mm apart and falls on a screen 1.5 m from the slits, find the distance between the first-order violet and the first-order red fringes.

\[
\gamma_1 = \frac{\lambda_1}{d} \Rightarrow \Delta \gamma_1 = \Delta \frac{\lambda_1}{d} = \frac{(700 - 400) \times 10^{-9}}{0.30 \times 10^{-3}} \text{m} \times (1.5\text{m})
\]

\[
\Rightarrow \Delta \gamma_1 = 1.5\text{mm}
\]

Problem 4
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 when water (n = 1.33) replaces the air between the plates.

- Assuming the glass plates have refractive indices greater than that of both air & H₂O, we have the same conditions as in problem 3.

  \[ 2t = n \lambda_n = n \left( \frac{\lambda_0}{n_{air}} \right) \text{ } n = 0, 1, 2, \ldots \]

  - The highest order dark band is \( n = 84 \) (total of 85 including 0).

  - The maximum thickness is \( t_{\text{max}} = \frac{\lambda_n}{2} \left( \frac{n_{air}}{n_{H₂O}} \right) = \frac{84}{2} \left( \frac{1}{1.33} \right) = 42 \lambda_0 \)

  - When we have H₂O in the wedge,

    \[ N_{\text{max}} = 2t_{\text{max}} \left( \frac{n_{H₂O}}{\lambda_0} \right) = 2 \left( 42 \lambda_0 \right) \left( \frac{1.33}{\lambda_0} \right) = 112 \]

  - including \( n=0 \) ⇒ total of 113 fringes.