

31. The wave reflected from the front surface suffers a phase change of π rad since it is incident in air on a medium of higher index of refraction. The phase of the wave reflected from the back surface does not change on reflection since the medium beyond the soap film is air and has a lower index of refraction than the film. If L is the thickness of the film, this wave travels a distance $2L$ farther than the wave reflected from the front surface. The phase difference of the two waves is $2L(2\pi/\lambda_f) - \pi$, where λ_f is the wavelength in the film. If λ is the wavelength in vacuum and n is the index of refraction of the soap film, then $\lambda_f = \lambda/n$ and the phase difference is

$$2nL \left(\frac{2\pi}{\lambda} \right) - \pi = 2(1.33)(1.21 \times 10^{-6} \text{ m}) \left(\frac{2\pi}{585 \times 10^{-9} \text{ m}} \right) - \pi = 10\pi \text{ rad} .$$

Since the phase difference is an even multiple of π , the interference is completely constructive.