Answer to Essential Question 25.7: Returning to the result of Step 3 in Exploration 25.7, the effective path-length difference between the two waves is $\Delta = 2t$. Thus, in the limit that the thickness, t, approaches zero, the effective path-length difference approaches zero and the interference is constructive.

Chapter Summary

Essential Idea: Interference and Diffraction.
In many situations, light acts as a wave. In general, waves diffract through narrow openings, and waves interfere with one another. Examples of this behavior with light occur when a laser beam is incident on one or more narrow openings, when light passes through the pupil of your eye, and when light interacts with thin films such as those in soap bubbles.

Constructive Interference – from Double Slits to Diffraction Gratings
For a wave of wavelength λ that is incident on a number of equally spaced narrow openings, where the number of openings is at least two, the angles at which constructive interference occurs are given by

$d \sin\theta = m\lambda$, (Equation 25.3: **constructive interference, for $N > 1$ sources)**
where m is an integer, and d is the distance between neighboring openings.

Destructive Interference – Single and Double Slits
For a wave of wavelength λ that is incident on a single slit of width a, the angles at which destructive interference occurs are given by

$a \sin\theta = m\lambda$, (Equation 25.5: **diffraction minima for a single slit)**
where m is an integer, and a is the distance between neighboring openings.

For a double slit, the interference minima occur at angles given by

$d \sin\theta = (m + 1/2)\lambda$, (Equation 25.4: **destructive interference, for two sources in phase**)
where m is an integer.

Limits imposed by diffraction
For a circular opening, the angle at which the first zero occurs in a diffraction pattern is given by

$\theta_{min} = \dfrac{1.22\lambda}{D}$, (Eq. 25.6: **The minimum angle between two sources to be resolvable**)

where D is the diameter of the opening. This equation can be applied to our own eyes.

Thin-film interference
The colorful patterns exhibited by thin films, such as soap bubbles, can be understood by following the five-step method outlined in Section 25.6. Such patterns result from the wave reflecting from one surface of the film interfering with the wave reflecting from the other surface of the film. A key part of the analysis is accounting for the fact that when waves in one medium reflect from a second medium that has a lower index of refraction, the reflected wave is upright, while if the second medium has a higher index of refraction, the reflected wave is inverted. This inversion upon reflection is like an extra half-wavelength distance traveled by the wave.