Guide to: interference problems, wave propagation in air or in dense media.

Applications: sound waves traveling in air; light waves traveling in vacuum, air, or dense media

Basic idea: two traveling waves, at the source they are in phase and have the same amplitude; due to a path length difference d one wave is delayed with respect to the other. If the phase delay corresponds to an integer multiple of the wavelength $m\lambda$ the waves add constructively; if the phase delay corresponds to a half-wavelength difference, the interference is destructive.

Complications: 1) electromagnetic waves in a medium: to account for the wavelength change in the medium apply the optical path length $n_1 d$ instead of the physical path length difference. Here n_1 is the index of refraction of the medium.

2) thin-film interference: reflection from a material interface where the refraction index changes from n_1 to n_2 with $n_2 > n_1$: the reflected wave is inverted as this interface, which corresponds to the addition of a half wavelength $\lambda/2$. If it happens in one of the paths only, it swaps constructive and destructive interference conditions.

Examples: Loudspeakers emitting the same sound, but being at a different distance from the observation point; Beam splitter with mirrors (Michelson interferometer); Light reflected from thin layers (oil, soapy water) resting on another optical medium (glass, water); Light passing from behind through glass plates stacked on top of each other and forming a micron-range gap in-between.

Equations: wavelength-frequency-propagation speed relation: $\lambda f = c_w$
right-traveling monochromatic wave: $y(x,t) = A\sin(kx - \omega t + \phi) \quad k = 2\pi/\lambda \quad \omega = 2\pi f$
EM wave propagation in medium: $c_w \to c_w/n \quad \lambda \to \lambda/n$
sound waves going from one medium to another: speed change implies wavelength change.

Problems:

12.39 calculate the path length difference; set up the interference condition for the wavelength; convert to frequency.
13.11 how does the wavelength of a sound wave change when it enters water?
wave on a string produces sound wave via soundboard oscillations: frequency remains the same, but wavelength for sound wave is different from wavelength on the string.
sections 25.2; 25.3; 25.5 on Young (double-slit) interference!