Wave Concepts and the Scalar Wave Equation

The scalar wave equation:

$$\nabla^2 \phi - \frac{n^2}{c_0^2} \frac{\partial^2 \phi}{\partial t^2} = 0$$

where c_0 is the velocity of light in vacuum,
n is the index of refraction $= c_0/c(x)$,
t is time, ∇ is the gradient with respect to spatial coordinate x, and ϕ is a scalar measure of the wave field.

Plane Wave Solution and Wave Vector

$$\phi = \phi_0 \, exp \, [i(k \cdot x - \omega t)]$$

is a plane wave solution of the wave equation, valid when the index of refraction $n(x)$ is constant in space.
The angular frequency $\omega = 2\pi f$, where f is the inverse of the period of oscillation (measured in Hz).
The wave vector k is a vector in the direction of propagation having magnitude (called the wavenumber)

$$k = \frac{n\omega}{c_0} = \frac{2\pi}{\lambda}$$

where $\lambda \equiv c_0/f$ is the wavelength.