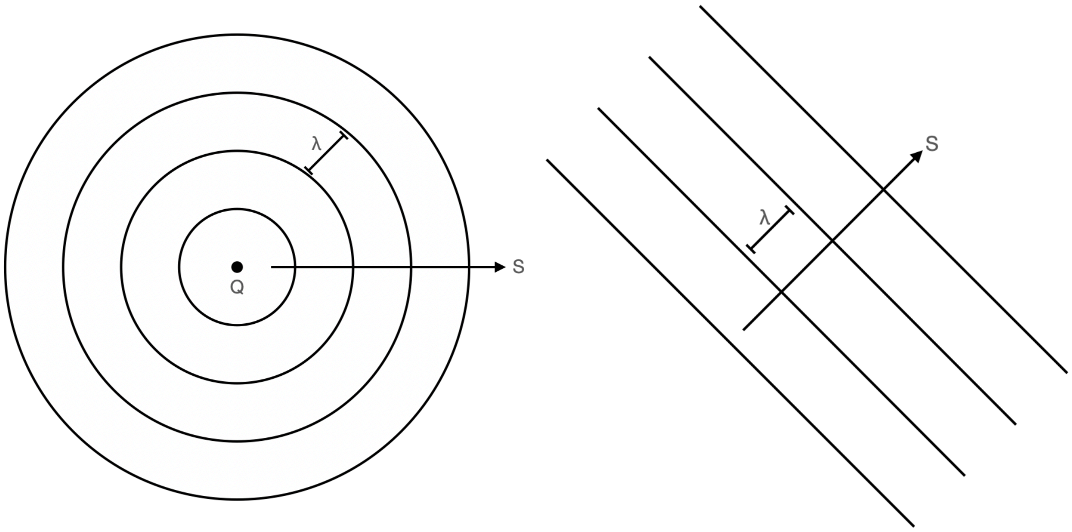
Lesson 3. Wave Propagation

A sound wave radiating outward from a central source produces a *wave front*. As the waves moves away from their source, their curvature decreases and they can be treated as *plane waves* perpendicular to one another.



The relationship of the wave's speed (S), frequency (f), and wavelength (λ) can be represented as $S = f\lambda$. The speed and frequency are independent of each other; the wavelength will change accordingly.

The speed of a wave in a gas is determined by the nature of the gas. It can be calculated with the formula

$$c = \sqrt{\frac{\gamma p}{\rho}}$$

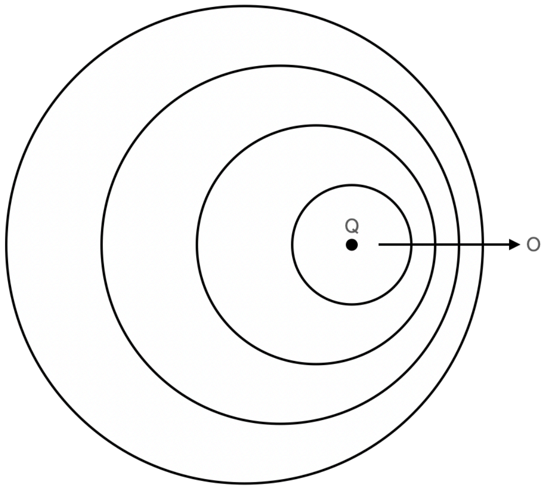
Where the speed c is the square root of the product of γ, a constant depending on the gas (1.4 for air), and p, the air pressure in newtons, divided by ρ, the density of the medium in kilograms per cubic meter.

Despite its appearing in the equation, air pressure does not affect the speed of sound, because air density will change in proportion with pressure as long as the temperature is constant.

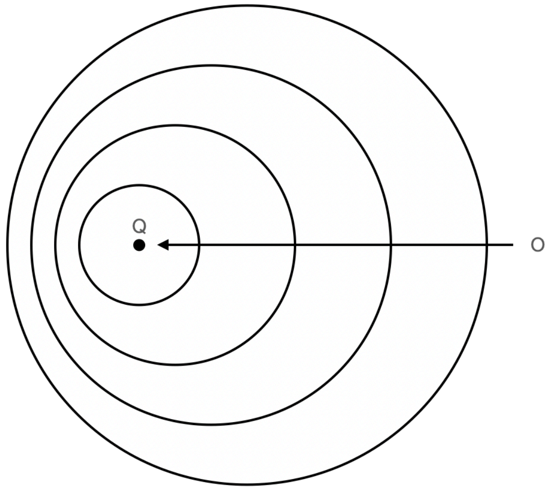
At standard conditions (0° Celsius and air pressure of 1.013×10^5 newtons per square meter), the speed of sound is 331.5 meters per second.

The Doppler Effect

If the source of a sound is moving toward the listener, the velocity of the source is subtracted from the wavelength as the source "catches up" with the wave front. Since the speed of sound is constant, this results in a higher frequency pitch for the listener. Alternatively, if the source is moving away from the listener, the velocity is added to the wavelength, resulting in a lower pitch.



Source moving toward observer



Source moving away from observer