

Chapter 14 Problem 35 †

Given

$$P = 6.2 \times 10^5 \text{ N/m}^2$$

$$\rho = 4.5 \text{ kg/m}^3$$

$$\gamma = 1.61$$

$$\lambda = 50 \text{ cm} = 0.50 \text{ m}$$

Solution

Find the frequency of the wave under these conditions.

First the velocity of the wave must be found. This depends on the density and pressure by the equation

$$v = \sqrt{\frac{\gamma P}{\rho}} \quad (1)$$

The relationship between velocity and frequency is

$$v = f \cdot \lambda \quad (2)$$

Combining Equations 1 and 2 and solving for frequency gives

$$f = \frac{v}{\lambda} = \frac{1}{\lambda} \sqrt{\frac{\gamma P}{\rho}} = \frac{1}{(0.50 \text{ m})} \sqrt{\frac{(1.61)(6.2 \times 10^5 \text{ N/m}^2)}{(4.5 \text{ kg/m}^3)}}$$

$$f = 942 \text{ Hz}$$

Under normal conditions in air the frequency would be

$$f = \frac{v}{\lambda} = \frac{(343 \text{ m/s})}{(0.5 \text{ m})} = 686 \text{ Hz}$$

†Problem from Essential University Physics, Wolfson