Problem 2.11

Compare the wavelengths of the A note ($\nu \approx 440$ Hz) played in air ($v \approx 343$ m/s) and water ($v \approx 1500$ m/s)?

Solution

The relationship between wavelength λ, frequency ν, and speed v for any wave is

$$\lambda\nu = v.$$

With the speed and the frequency, the wavelength can be calculated.

$$\text{Air:} \qquad \lambda = \frac{v}{\nu} = \frac{343 \ \frac{\text{m}}{\text{s}}}{440 \text{ Hz}} \approx 0.78 \text{ m}$$

$$\text{Water:} \qquad \lambda = \frac{v}{\nu} = \frac{1500 \ \frac{\text{m}}{\text{s}}}{440 \text{ Hz}} \approx 3.4 \text{ m}$$

Use the formula for percent difference to find out how much bigger the wavelength is in water than in air.

$$\frac{\text{Air\_Wavelength} - \text{Water\_Wavelength}}{\text{Water\_Wavelength}} \times 100\% = \frac{\frac{343}{400} - \frac{1500}{440}}{\frac{1500}{440}} \times 100\% \approx -77.1\%$$

Therefore, the A note wavelength is 77.1% smaller in air than it is in water.