

37. The top of the water is a displacement node and the top of the well is a displacement antinode. At the lowest resonant frequency exactly one-fourth of a wavelength fits into the depth of the well. If d is the depth and λ is the wavelength then $\lambda = 4d$. The frequency is $f = v/\lambda = v/4d$, where v is the speed of sound. The speed of sound is given by $v = \sqrt{B/\rho}$, where B is the bulk modulus and ρ is the density of air in the well. Thus $f = (1/4d)\sqrt{B/\rho}$ and

$$d = \frac{1}{4f} \sqrt{\frac{B}{\rho}} = \left[\frac{1}{4(7.00 \text{ Hz})} \right] \sqrt{\frac{1.33 \times 10^5 \text{ Pa}}{1.10 \text{ kg/m}^3}} = 12.4 \text{ m} .$$