

15.28. Model: The water pressure applies a volume stress to the sphere.

Solve: The volume change is $\Delta V = -1.0 \times 10^{-3} V$. The volume stress is

$$\frac{F}{A} = p = -B \frac{\Delta V}{V} = -(7 \times 10^{10} \text{ N/m}^2) \frac{-1.0 \times 10^{-3} V}{V} = 7.0 \times 10^7 \text{ Pa}$$

Using $p = p_0 + \rho gh$, we get

$$7 \times 10^7 \text{ Pa} = 1.013 \times 10^5 \text{ Pa} + (1030 \text{ kg/m}^3)(9.8 \text{ m/s}^2)d \Rightarrow d = 6.92 \text{ km}$$

Assess: A pressure of $7 \times 10^7 \text{ Pa} = 690 \text{ atm}$ causes only a volume change of 0.1%. This is reasonable because liquids and solids are nearly incompressible.