15. We assume that the pressure of the air in the bubble is essentially the same as the pressure in the surrounding water. If d is the depth of the lake and ρ is the density of water, then the pressure at the bottom of the lake is $p_1 = p_0 + \rho g d$, where p_0 is atmospheric pressure. Since $p_1 V_1 = nRT_1$, the number of moles of gas in the bubble is $n = p_1 V_1 / RT_1 = (p_0 + \rho g d) V_1 / RT_1$, where V_1 is the volume of the bubble at the bottom of the lake and T_1 is the temperature there. At the surface of the lake the pressure is p_0 and the volume of the bubble is $V_2 = nRT_2/p_0$. We substitute for n to obtain

$$\begin{aligned} V_2 &= \frac{T_2}{T_1} \frac{p_0 + \rho g d}{p_0} V_1 \\ &= \left(\frac{293\,\text{K}}{277\,\text{K}}\right) \left(\frac{1.013 \times 10^5\,\text{Pa} + (0.998 \times 10^3\,\text{kg/m}^3)(9.8\,\text{m/s}^2)(40\,\text{m})}{1.013 \times 10^5\,\text{Pa}}\right) (20\,\text{cm}^3) \\ &= 100\ \text{cm}^3\ . \end{aligned}$$