# Equilibrium Solubility of Oxygen in Water

Problem 13-42

At 1.00 atm, the solubility of $O_2$ in water is $2.18 \times 10^{-3}$M at 0°C and $1.26 \times 10^{-3}$M at 25°C. What volume of $O_2$(g), measured at 25°C and 1.00 atm, is expelled when 515 mL of water saturated with $O_2$ is heated from 0 to 25°C?

**Solution:**

This integrative problem simply combines gas laws from earlier chapters to solution concentration. It really doesn't have anything macroscopically to do with intermolecular forces.

Calculate the molar quantity of $O_2$ in the cold solution and then the warm solution:

$$n_{\mathrm{O_2}}^{0^\circ} = \left(2.18\times10^{-3}\ \tfrac{\mathrm{mol\ O_2}}{\mathrm{L}}\right)\times 0.515\ \mathrm{L} = 0.001123\ \mathrm{mol\ O_2}$$

$$n_{\mathrm{O_2}}^{25^\circ} = \left(1.26\times10^{-3}\ \tfrac{\mathrm{mol\ O_2}}{\mathrm{L}}\right)\times 0.515\ \mathrm{L} = 0.0006489\ \mathrm{mol\ O_2}$$

The difference between these two quantities is the amount of $O_2$ expelled.

$$n_{\mathrm{O_2}}^{\mathrm{expelled}} = 0.001123\ \mathrm{mol} - 0.0006489\ \mathrm{mol} = 4.738\times10^{-4}\,\mathrm{mol\ O_2}$$

Now it's simply a gas law problem to calculate volume:

$$\frac{PV}{nT} = R$$

$$n_{\mathrm{O_2}} = 4.738\times10^{-4}\,\mathrm{mol\ O_2}$$

$$T = 298.15\ \mathrm{K}$$

$$P = 1.00\ \mathrm{atm}$$

$$V = \frac{nTR}{P} = \frac{(4.738\times10^{-4}\,\mathrm{mol})(298.15\ \mathrm{K})(0.082059\ \tfrac{\mathrm{L\cdot atm}}{\mathrm{mol\cdot K}})}{1.00\ \mathrm{atm}} = 0.0116\ \mathrm{L\ O_2}$$