Saturated and Unsaturated Solutions

Problem 2-63

A solution is prepared by dissolving 2.50 g potassium chlorate (a substance used in fireworks and flares) in 100.0 mL water at 40°C. When the solution was cooled to 20°C, its volume was found to still be 100.0 mL, but some of the potassium chlorate had crystallized (deposited from the solution as a solid). At 40°C, the density of water is 0.9922 g/mL, and at 20°C the potassium chlorate solution had a density of 1.0085 g/mL.

(**a**) Estimate, to two significant figures, the mass of potassium chlorate that crystallized.

(**b**) Why can't the answer in (a) be given more precisely?

Solution:

One key to this problem is realizing that the mass of water remains unchanged even though the volume of the water and solution does.

$$m_{H_2O,40°C} = 100.0 \text{ mL} \times 0.9922 \frac{\text{g}}{\text{mL}} = 99.22 \text{ g } H_2O$$

$$m_{\text{soln},20°C} = 100.0 \text{ mL} \times 1.0085 \frac{\text{g}}{\text{mL}} = 100.85 \text{ g solution}$$

The mass of water remains unchanged. The mass of the solution is the sum of the mass of the water and potassium chlorate.

$$m_{KClO_3 \text{ in solution}} = 100.85 \text{ g solution} - 99.22 \text{ g } H_2O = 1.63 \text{ g } KClO_3$$

$$\boxed{m_{KClO_3 \text{ crystallized}} = 2.50 \text{ g} - 1.63 \text{ g} = 0.87 \text{ g}}$$

The precision is poor compared to all of the other measurements due to the loss of significant figures in the subtraction.