

# Take-Home Assignment 03 Key

A mixture of solid  $\text{NaNO}_3$  and solid  $\text{KF}$ , with a combined mass of 9.819 g, is added to water in a perfectly insulated calorimeter and allowed to dissolve. When dissolution is complete, the temperature of the solution has increased by  $1.35^\circ\text{C}$  and the solution is found to weigh 89.930 g. The dissolution reactions and their enthalpy changes are

reaction	$\Delta H^\circ$
$\text{NaNO}_3(s) \rightarrow \text{NaNO}_3(aq)$	+20.4 kJ/mol <sub>rxn</sub>
$\text{KF}(s) \rightarrow \text{KF}(aq)$	-17.6 kJ/mol <sub>rxn</sub>

Assuming that the specific heat of the solution is  $4.184 \text{ J/g} \cdot ^\circ\text{C}$ , determine the grams of  $\text{NaNO}_3$  and the grams of  $\text{KF}$  in the mixture, and report the % $\text{KF}$  in the mixture. Place your work in the space below and turn in this take-home assignment one week from today. Your sample number is 46c.

## Solution

First, we calculate  $q_{\text{solution}}$ , which is

$$89.930 \text{ g} \times 4.184 \text{ J/g} \cdot ^\circ\text{C} \times 1.35^\circ\text{C} = 506.778 \text{ J}$$

Next, we note that

$$-q_{\text{solution}} = q_{\text{K}} + q_{\text{Na}}$$

$$-q_{\text{solution}} = \frac{\Delta H_{\text{K}}^\circ \times g_{\text{K}}}{FW_{\text{K}}} + \frac{\Delta H_{\text{Na}}^\circ \times g_{\text{Na}}}{FW_{\text{Na}}}$$

where K represents  $\text{KF}$  and where Na represents  $\text{NaNO}_3$ . Substituting in known values, and recognizing that  $g_{\text{N}} = \text{total mass of mixture} - g_{\text{K}}$

$$-506.778 \text{ J} = \frac{-17600 \text{ J/mol} \times g_{\text{K}}}{58.10\text{g/mol}} + \frac{20400 \text{ J/mol} \times (9.819 \text{ g} - g_{\text{K}})}{84.99\text{g/mol}}$$

and solving gives 5.354 g of  $\text{KF}$ , 4.465 g of  $\text{NaNO}_3$ . The mass percent of  $\text{KF}$  in the sample is 54.53 %.