Practice Exercise 8.3

A sample of a silicate rock that weighs 0.8143 g is brought into solution and treated to yield a 0.2692-g mixture of NaCl and KCl. The mixture of chloride salts is dissolved in a mixture of ethanol and water, and treated with $HClO_4$, precipitating 0.3314 g of $KClO_4$. What is the %w/w Na_2O in the silicate rock?

Solution to Practice Exercise 8.3

The mass of the two solids provides us with the following set of equations

$$\text{g NaCl} + \text{g KCl} = 0.2692 \text{ g}$$

$$\text{g KClO}_4 = 0.3314 \text{ g}$$

With two equations and three unknowns—g NaCl, g KCl, and g $KClO_4$—we need one additional equation to solve the problem. A conservation of mass requires that all the potassium originally in the KCl ends up in the $KClO_4$; thus

$$\text{g KClO}_4 = \text{g KCl} \times \frac{\text{1mol Cl}}{\text{74.55 g KCl}} \times \frac{\text{138.55 g KClO}_4}{\text{mol Cl}} = 1.8585 \times \text{g KCl}$$

Given the mass of $KClO_4$, we use the third equation to solve for the mass of KCl in the mixture of chloride salts

$$\text{g KCl} = \frac{\text{g KClO}_4}{1.8585} = \frac{0.3314 \text{ g}}{1.8585} = 0.1783 \text{ g KCl}$$

Tha mass of NaCl in the mixture of chloride salts, therefore, is

$$\text{g NaCl} = 0.2692 \text{ g} - \text{g KCl} = 0.2692 \text{ g} - 0.1783 \text{ g KCl} = 0.0909 \text{ g NaCl}$$

Finally, to report the %w/w Na_2O in the sample, we use a conservation of mass on sodium to determine the mass of Na_2O

$$0.0909 \text{ g NaCl} \times \frac{\text{1 mol Na}}{\text{58.44 g NaCl}} \times \frac{\text{61.98 g Na}_2\text{O}}{\text{2 mol Na}} = 0.0482 \text{ g Na}_2\text{O}$$

giving the %w/w Na_2O as

$$\frac{0.0482 \text{ g Na}_2\text{O}}{0.8143 \text{ g sample}} \times 100 = 5.92\% \text{ w/w Na}_2\text{O}$$