STOICHIOMETRY AND PERCENT PURITY

Many samples of chemicals are not pure. We can define percent purity as

$$\frac{\text{mass of pure compound in the impure sample}}{\text{total mass of impure sample}} \times 100$$

If an impure sample of a chemical of **known** percent purity is used in a chemical reaction, the percent purity has to be used in stoichiometric calculations. Conversely, the percent purity of an impure sample of a chemical of **unknown** percent purity can be determined by reaction with a pure compound as in an acid-base titration. Percent purity can also be determined, in theory, by measuring the amount of product obtained from a reaction. This latter approach, however, assumes a 100% yield of the product.

Examples

Consider the reaction of magnesium hydroxide with phosphoric acid.

$$3Mg(OH)_2 + 2H_3PO_4 \rightarrow Mg_3(PO_4)_2 + 6H_2O$$

(a) Calculate the mass of $Mg_3(PO_4)_2$ that will be formed (assuming a 100% yield) from the reaction of 15.0 g of 92.5% $Mg(OH)_2$ with an excess of H_3PO_4.

mass $Mg(OH)_2$ = 15.0 x 0.925 = 13.875 g

mass $Mg_3(PO_4)_2$ =

$$13.875 \text{ g } Mg(OH)_2 \times \frac{1 \text{ mole } Mg(OH)_2}{58.3 \text{ g } Mg(OH)_2} \times \frac{1 \text{ mole } Mg_3(PO_4)_2}{3 \text{ moles } Mg(OH)_2} \times \frac{262.9 \text{ g } Mg_3(PO_4)_2}{1 \text{ mole } Mg_3(PO_4)_2}$$

= 20.9 g $Mg_3(PO_4)_2$

(b) Calculate the mass of 88.5% $Mg(OH)_2$ needed to make 127 g of $Mg_3(PO_4)_2$, assuming a 100% yield.

mass $Mg(OH)_2$ =

$$127 \text{ g } Mg_3(PO_4)_2 \times \frac{1 \text{ mole } Mg_3(PO_4)_2}{262.9 \text{ g } Mg_3(PO_4)_2} \times \frac{3 \text{ moles } Mg(OH)_2}{1 \text{ mole } Mg_3(PO_4)_2} \times \frac{58.3 \text{ g } Mg(OH)_2}{1 \text{ mole } Mg(OH)_2}$$

= 84.49 g $Mg(OH)_2$.

$$\text{mass } 88.5\% \ Mg(OH)_2 = 84.49 \text{ g } Mg(OH)_2 \times \frac{100 \text{ g } 88.5\% \ Mg(OH)_2}{88.5 \text{ g } Mg(OH)_2} = 95.5 \text{ g}$$

(c) Calculate the percent purity of a sample of $Mg(OH)_2$ if titration of 2.568 g of the sample required 38.45 mL of 0.6695 *M* H_3PO_4.

mass $Mg(OH)_2$ =

$$38.45 \text{ mL } H_3PO_4 \times \frac{0.6695 \text{ mole } H_3PO_4}{1000 \text{ mL } H_3PO_4} \times \frac{3 \text{ moles } Mg(OH)_2}{2 \text{ moles } H_3PO_4} \times \frac{58.3 \text{ g } Mg(OH)_2}{1 \text{ mole } Mg(OH)_2}$$

= 2.251 g $Mg(OH)_2$. Percent purity = $\frac{2.251}{2.568} \times 100 = 87.7\%$