Answer on Question #46059, Chemistry, Other

Task:

$CaCO_3 + 2HCl > CaCl_2 + H_2O + CO_2$

a.) 45.0 g $CaCO_3$ are added to 1.25 L of a 25.7% (w/v) solution of HCl. Calculate the theoretical yield of CO_2 formed.

b.) Calculate the mass of $CaCO_3$ and volume of HCl solution required to produce 25.0 g of CO_2. The reaction is 78.0% efficient.

Answer:

a) $v = \frac{m}{M}$

$$v(CaCO_3) = \frac{45}{100} = 0.45\,mol$$

M($CaCO_3$)=100 g/mol

$$Volume\ percent = \frac{Weight\ of\ solute\,(g)}{Volume\ of\ solution\,(mL)} \cdot 100\%$$

$$m(HCl) = \frac{1250 \cdot 25.7}{100} = 321{,}3\,g$$

M(HCl)=36.5 g/mol

$$v(HCl) = \frac{321.5}{36.5} = 8.8\,mol$$

From these calculations we can say, that HCl is in excess and $CaCO_3$ is the limiting reagent.

$$v(CO_2) = v(CaCO_3) = 0.45\,mol$$

$$v(CO_2) = \frac{V(CO_2)}{22.4}$$

$$V(CO_2) = v(CO_2) \cdot 22.4 = 0.45 \cdot 22.4 = 10.08\,l$$

b) 25.0 g of CO_2 is only 78% of the reaction product. So, the 100% amount will be:

$$m(CO_2) = \frac{25 \cdot 100}{78} = 32{,}05\,g$$

$$v(CO_2) = \frac{m(CO_2)}{M(CO_2)} = \frac{32{,}05}{44} = 0.73\,mol$$

According to the equestion:

$$v(HCl) = 2 \cdot v(CO_2) = 2 \cdot 0.73\,mol = 1.46\,mol$$

$$v(\tilde{N}aCO_3) = v(CO_2) = 0.73\,mol$$

$$v = \frac{m}{M}$$

$$m(HCl) = v(HCl) \cdot M(HCl) = 1.46 \cdot 36.5 = 53.3\,g$$

We will use the concentration 25.7% (w/v). So, the amount of this solution will be:

$$V(HCl) = \frac{53.3 \cdot 100}{25{,}7} = 207\,mL$$

$$m(CaCO_3) = v(CaCO_3) \cdot M(CaCO_3) = 0.73 \cdot 100 = 73g$$