Answer on Question #82415 – Chemistry – General Chemistry

Question

Aluminum dissolves in an aqueous solution of $NaOH$ according to the following reaction: $2NaOH + 2Al + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$ If $84.1g$ of $NaOH$ and $51.0g$ of Al react, which is the limiting reagent? How much of the other reagent remains? What mass of hydrogen is produced?

Solution

To answer the question, molar masses of $NaOH$, Al and H_2 are required.
$M_{NaOH} \approx 40\frac{g}{mol}$, $M_{Al} \approx 27\frac{g}{mol}$, $M_{H_2} \approx 2\frac{g}{mol}$.
Then it is possible to calculate the chemical amounts of $NaOH$ and Al: $n = \frac{m}{M}$.

$$n_{NaOH} = \frac{m_{NaOH}}{M_{NaOH}} = \frac{84.1g}{40\frac{g}{mol}} = 2.1025mol;\ \ n_{Al} = \frac{m_{Al}}{M_{Al}} = \frac{51.0g}{27\frac{g}{mol}} \approx 1.8889mol.$$

From equation of the reaction it follows, that for every two moles of $NaOH$ it should be two moles of Al. However, the chemical amount of Al is less, than the chemical amount of $NaOH$. Therefore, Al is the limiting reagent. After reaction it remains $n_{NaOH(2)} = n_{NaOH} - n_{Al} = = 2.1025mol - 1.8889mol = 0.2136mol$ of $NaOH$. It weighs $m_{NaOH} = M_{NaOH} \times n_{NaOH(2)} = = 40\frac{g}{mol} \times 0.2136mol = 8.544g$.
For every two moles of Al, three moles of H_2 are produced. Then, chemical amount of produced H_2 equals $\frac{3}{2}$ of the chemical amount of Al: $n_{H_2} = \frac{3}{2} \times n_{Al} = \frac{3}{2} \times 1.8889mol = 2.83335mol$.
$m_{H_2} = M_{H_2} \times n_{H_2} = 2\frac{g}{mol} \times 2.8335mol = 5.6667g$.

Answer: Al is the limiting reagent. After reaction it remains $0.2136mol$ or $8.544g$ of $NaOH$. $5.6667g$ of H_2 is produced.