Answer on Question #39969 - Chemistry – Inorganic Chemistry

Question

1.30g H2 is allowed to react with 10.4g N2 producing 2.74g NH3. Calculate the theoretical yield for the reaction and the percentage yield of the reaction.

Answer:

A balanced equation for the reaction:

$$3H_2 + N_2 = 2NH_3$$

Number of moles equals:

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

m – Mass of the substance, g.

M – Molar mass of the substance, g/mol.

Molar masses of the reactants equal:

$$M(H_2) = 2.016 \text{ g/mol}, \quad M(N_2) = 28.014 \text{ g/mol}$$

Number of moles of the reactants:

$$n(H_2) = \frac{m(H_2)}{M(H_{2)}} = \frac{1.30}{2.016} = 0.645\ moles$$

$$n(N_2) = \frac{m(N_2)}{M(N_{2)}} = \frac{10.4}{28.014} = 0.371\ moles$$

Then we make a proportion:

3 moles of H_2 react with 1 moles of N_2

0.645 moles of H_2 – *x* moles of N_2

$$x = \frac{0.645 \cdot 1}{3} = 0.215\ moles\ of\ N_2\ will\ react\ with\ 0.645\ moles\ of\ H_2$$

We have 0.371 moles of nitrogen, therefore it is in excess. If it is in excess then the hydrogen is the limiting reactant.

We need to make another proportion to calculate the theoretical yield for the reaction:

3 moles of H_2 produce 2 moles of NH_3

0.645 moles of H_2 – *x* moles of NH_3

$$x = \frac{0.645 \cdot 2}{3} = 0.43\ moles\ of\ NH_3\ could\ be\ produced$$

The theoretical yield for the reaction equals:

$$m_t(NH_3) = n(NH_3) \cdot M(NH_3) = 0.43 \cdot 15.015 = 6.46\ g$$

The percentage yield of the reaction equals:

$$\%yield = \frac{m_p(NH_3)}{m_t(NH_3)} \times 100\% = \frac{2.74}{6.46} \times 100\% = 42.4\%$$

Answer: Theoretical yield equals 6.46 g of NH_3, percentage yield equals 42.4%.