QUESTION OF THE DAY

Problem: 67 grams of hydrogen and 336 grams of nitrogen are reacted together to form ammonia, how much ammonia is produced if the reaction goes to completion?

Solution

The reaction stated is $3H_2 + N_2 \rightarrow 2NH_3$

The first step is to turn the mass of the reactants into moles

67 g H_2 $\left(\frac{1mol}{2.016g}\right)$ = 33 mol H_2

336 g N_2 $\left(\frac{1mol}{28.02g}\right)$ = 12.0 mol N_2

Next, determine the limiting reactant

If 33 mol H_2 are used, then $(33 \cdot mol \cdot H_2)\left(\frac{1 \cdot mol \cdot N_2}{3 \cdot mol \cdot H_2}\right)$ = 11 mol N_2

Since only 11 mol N_2 are required to use all of the hydrogen, and there is more than 11 mol N_2, this means that N_2 is in excess. Thus, H_2 should be the limiting reagent. We can check this by:

If 12.0 mol N_2 are used, then $(12.0 \cdot mol \cdot N_2)\left(\frac{3 \cdot mol \cdot H_2}{1 \cdot mol \cdot N_2}\right)$ = 36 mol H_2 which states that 36 mol H_2 are needed to use all of the N_2, but we only have 33 mol H_2. Thus, H_2 is the limiting reagent.

Use the 33 mol H_2 to determine the amount of NH_3 produced.

$$(33 \cdot mol \cdot H_2)\left(\frac{2 \cdot mol \cdot NH_3}{3 \cdot mol \cdot H_2}\right) = 22 \text{ mol } NH_3 = (22 \cdot mol \cdot NH_3)\left(\frac{17.03 \cdot g \cdot NH_3}{1 \cdot mol \cdot NH_3}\right) = 375 \text{ g } NH_3$$

These quantities of reactants will yield 375 g NH_3