

Answer on Question #64905 - Chemistry - General Chemistry

Question: a solution of 8.50 g sodium phosphate is mixed with a solution containing 6.40 g barium nitrate. How many grams of NaNO_3 product can be formed? What is the limiting reagent?

Solution

1) Calculate the molar masses of reagents:

$$M(\text{Na}_3\text{PO}_4) = 3A(\text{Na}) + A(\text{P}) + 4A(\text{O}) = 3 * 23 + 31 + 4 * 16 = 164 \frac{\text{g}}{\text{mol}};$$

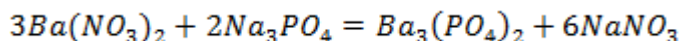
$$M(\text{Ba}(\text{NO}_3)_2) = A(\text{Ba}) + 2A(\text{N}) + 6A(\text{O}) = 137.3 + 2 * 14 + 6 * 16 = 261.3 \frac{\text{g}}{\text{mol}}.$$

2) Find the amounts of substance of both reagents:

$$n(\text{Na}_3\text{PO}_4) = \frac{m(\text{Na}_3\text{PO}_4)}{M(\text{Na}_3\text{PO}_4)} = \frac{8.5}{164} \approx 5.183 * 10^{-2} \text{ mol}$$

$$n(\text{Ba}(\text{NO}_3)_2) = \frac{m(\text{Ba}(\text{NO}_3)_2)}{M(\text{Ba}(\text{NO}_3)_2)} = \frac{6.4}{261.3} \approx 2.449 * 10^{-2} \text{ mol}$$

3) Write the balanced equation for this reaction:



So, the reagents react in the molar ratio 3:2 (3 moles of barium nitrate per 2 moles of sodium phosphate). The limiting reagent in our case is barium nitrate, because its amount of substance is smaller than the amount of substance of sodium phosphate, and according to the balanced equation its amount must be 1.5 times bigger. To react with $5.183 * 10^{-2}$ moles of sodium phosphate, we need $5.183 * 10^{-2} * 1.5 = 7.7745 * 10^{-2}$ moles of barium nitrate. So, the amount and mass of products must be calculated by the mass of barium nitrate.

4) Calculate the mass of NaNO_3 product by the limiting reagent according to the balanced reaction equation ($M(\text{NaNO}_3) = A(\text{Na}) + A(\text{N}) + 3A(\text{O}) = 23 + 14 + 3 * 16 = 85 \frac{\text{g}}{\text{mol}}$)

$$m(\text{NaNO}_3) = \frac{m(\text{Ba}(\text{NO}_3)_2) * 6M(\text{NaNO}_3)}{3M(\text{Ba}(\text{NO}_3)_2)} = \frac{6.4 * 6 * 85}{3 * 261.3} \approx 4.1638 \text{ g}$$

Answer: the limiting reagent in this reaction is barium nitrate. 4.1638 grams of NaNO_3 product can be formed.

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