Answer on Question #43920 - Chemistry - Inorganic Chemistry

Task:

What is the theoretical yield (in grams) of P4O10 if 35.8 g of P4 are reacted with 40.0 g of O2?

Solution:

1. The chemical equation for the reaction is

$P_4 + 5O_2 = P_4O_{10}$

2. The number of moles of P_4 is

$$n(P_4) = \frac{m(P_4)}{M(P_4)} = \frac{35.8\ g}{31\frac{g}{mol} \cdot 4} = 0.289\ mol$$

3. The number of moles of O_2 is

$$n(O_2) = \frac{m(O_2)}{M(O_2)} = \frac{40.0\ g}{16\frac{g}{mol} \cdot 2} = 1.25\ mol$$

4. According to the equation the ratio of number of moles is $n(P_4) : n(O_2) = 1 : 5$

$n(P_4) = n(O_2)/5 = 1.25/5 = 0.25$ mol, but we have more P4 than we need according to the equation. That means that O_2 is limiting reagent and we have to use $n(O_2)$ for calculations.

5. The number of moles of P_4O_{10} is

$$n(P_4O_{10}) = \frac{n(O_2)}{5} = \frac{1.25\ mol}{5} = 0.25\ mol$$

6. The mass of P_4O_{10} is

$$m(P_4O_{10}) = n(P_4O_{10}) \cdot M(P_4O_{10}) = 0.25 \cdot 284 = 71\ g$$

Answer:

$m(P_4O_{10}) = 71\ g$