

Limiting ReactantKey Concepts:

- The limiting reactant is the reactant that is completely used up during the chemical reaction.
- Excess reactant - reactant not completely used up - some of this reactant left over.

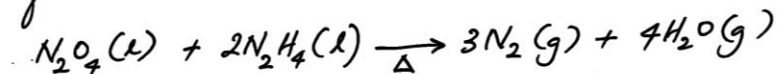
Example 1

Hydrazine,  $N_2H_4$  and dinitrogen tetroxide,  $N_2O_4$  which ignite to form nitrogen gas and water vapor. How many grams of nitrogen gas form when  $1.00 \times 10^2 g$  of  $N_2H_4$  and  $2.00 \times 10^2 g$  of  $N_2O_4$  are mixed?

Solution:

\* Because of amounts of two reactants are given, we know this is a limiting-reactant problem.

Balanced equation:



$$n_{N_2H_4} = \left( \frac{1.00 \times 10^2 g}{32.05 \text{ g mol}^{-1}} \right) = 3.12 \text{ mol}$$

$$n_{N_2O_4} = \left( \frac{2.00 \times 10^2 g}{92.02 \text{ g mol}^{-1}} \right) = 2.17 \text{ mol}$$

$$\begin{cases} M_r(N_2H_4) = 32.05 \text{ g mol}^{-1} \\ M_r(N_2O_4) = 92.02 \text{ g mol}^{-1} \\ M_r(N_2) = 28.02 \text{ g mol}^{-1} \end{cases}$$

$$r_{\text{theory}} = \frac{n_{N_2H_4}}{n_{N_2O_4}} = \frac{2}{1} = 2.0 \quad (\text{from the balanced equation})$$

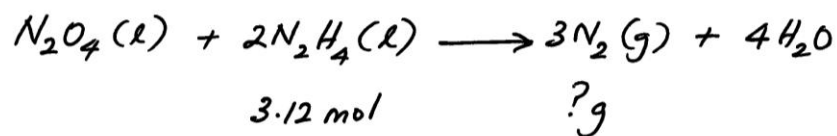
$$r_{\text{experiment}} = \frac{n_{N_2H_4}}{n_{N_2O_4}} = \frac{2.17 \text{ mol}}{3.12 \text{ mol}} = 0.696$$

$$r_{\text{experiment}} (0.696) < r_{\text{theory}} (2.0)$$

So the numerator ( $n_{N_2H_4}$ ) is a small value, i.e.  $N_2H_4$  is a limiting reactant, whereas the denominator,  $n_{N_2O_4}$  is a large value, i.e.  $N_2O_4$  is in excess.

## STOICHIOMETRY : LIMITING REACTANT

Since  $N_2H_4$  is a limiting reactant,



$$\frac{n_{N_2}}{n_{N_2H_4}} = \frac{3}{2} \quad \text{or} \quad n_{N_2} = \frac{3}{2} \times n_{N_2H_4}$$

$$\frac{m_{N_2}}{28.02 \text{ g mol}^{-1}} = \frac{3}{2} \times 3.12 \text{ mol}$$

$$\therefore m_{N_2} = \left( \frac{3 \times 3.12 \times 28.02}{2} \right) g$$
$$= 131 g \text{ (Ans)}$$

### Common Mistakes done by students !!

- The limiting reactant is not the reactant present in fewer moles (2.17 mol  $N_2O_4$  & 3.12 mol of  $N_2H_4$ ).
- The limiting reactant that forms fewer moles of product.
- The limiting reactant is not the reactant present in fewer mass. Rather it forms the lower mass of product.

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