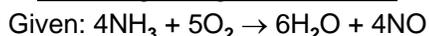


# Limiting Reagents



Caution: this stuff is difficult to follow at first.  
Be patient.

## Limiting reagent defined



Q - How many moles of NO are produced if \_\_\_ mol  $\text{NH}_3$  are burned in \_\_\_ mol  $\text{O}_2$ ?

4 mol  $\text{NH}_3$ , 5 mol  $\text{O}_2$

4 mol  $\text{NH}_3$ , 20 mol  $\text{O}_2$

8 mol  $\text{NH}_3$ , 20 mol  $\text{O}_2$

- Here,  $\text{NH}_3$  limits the production of NO; if there was more  $\text{NH}_3$ , more NO would be produced
- Thus,  $\text{NH}_3$  is called the "limiting reagent"
- 4 mol  $\text{NH}_3$ , 2.5 mol  $\text{O}_2$
- In limiting reagent questions we use the limiting reagent as the "given quantity" and ignore the reagent that is in excess ...

## Limiting reagents in stoichiometry

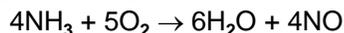


E.g. How many grams of NO are produced if 4 moles  $\text{NH}_3$  are burned in 20 mol  $\text{O}_2$ ?

Since  $\text{NH}_3$  is the limiting reagent we will use this as our "given quantity" in the calculation

- Sometimes the question is more complicated. For example, if grams of the two reactants are given instead of moles we must first determine moles, then decide which is limiting ...

## Solving Limiting reagents 1: g to mol



Q - How many g NO are produced if 20 g  $\text{NH}_3$  is burned in 30 g  $\text{O}_2$ ?

A - First we need to calculate the number of moles of each reactant

A - Once the number of moles of each is calculated we can determine the limiting reagent via a chart ...

## 2: Comparison chart

	$\text{NH}_3$	$\text{O}_2$
What we have*	1.176	0.937
	$\frac{1.176}{0.937}$ = 1.25 mol	$\frac{0.937}{0.937}$ = 1 mol
What we need**	4	5
	$\frac{4}{5} = 0.8$ mol	$\frac{5}{5} = 1$ mol

\*Choose the smallest value to divide each by

\*\* You should have "1 mol" in the same column twice in order to make a comparison

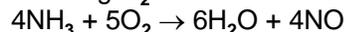
A - There is more  $\text{NH}_3$  (what we have) than needed (what we need). Thus  $\text{NH}_3$  is in excess, and  $\text{O}_2$  is the limiting reagent.

## 3: Stoichiometry (given = limiting)

So far we have followed two steps ...

- 1) Expressed all chemical quantities as moles
- 2) Determined the limiting reagent via a chart  
Finally we need to ...
- 3) Perform the stoichiometry using the limiting reagent as the "given" quantity

Q - How many g NO are produced if 20 g  $\text{NH}_3$  is burned in 30 g  $\text{O}_2$ ?



## Limiting Reagents: shortcut

- Limiting reagent problems can be solved another way (without using a chart)...
- Do two separate calculations using both given quantities. The smaller answer is correct.

Q - How many g NO are produced if 20 g  $\text{NH}_3$  is burned in 30 g  $\text{O}_2$ ?  $4\text{NH}_3 + 5\text{O}_2 \rightarrow 6\text{H}_2\text{O} + 4\text{NO}$   
# g NO =

$$20 \text{ g } \text{NH}_3 \times \frac{1 \text{ mol } \text{NH}_3}{17.0 \text{ g } \text{NH}_3} \times \frac{4 \text{ mol } \text{NO}}{4 \text{ mol } \text{NH}_3} \times \frac{30.0 \text{ g } \text{NO}}{1 \text{ mol } \text{NO}} = 35.3 \text{ g } \text{NO}$$

$$30 \text{ g } \text{O}_2 \times \frac{1 \text{ mol } \text{O}_2}{32.0 \text{ g } \text{O}_2} \times \frac{4 \text{ mol } \text{NO}}{5 \text{ mol } \text{O}_2} \times \frac{30.0 \text{ g } \text{NO}}{1 \text{ mol } \text{NO}} = 22.5 \text{ g } \text{NO}$$

## Practice questions

1.  $2\text{Al} + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2$   
If 25 g of aluminum was added to 90 g of HCl, what mass of  $\text{H}_2$  will be produced (try this two ways - with a chart & using the shortcut)?
2.  $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$ : If you have 20 g of  $\text{N}_2$  and 5.0 g of  $\text{H}_2$ , which is the limiting reagent?
3. What mass of aluminum oxide is formed when 10.0 g of Al is burned in 20.0 g of  $\text{O}_2$ ?
4. When  $\text{C}_3\text{H}_8$  burns in oxygen,  $\text{CO}_2$  and  $\text{H}_2\text{O}$  are produced. If 15.0 g of  $\text{C}_3\text{H}_8$  reacts with 60.0 g of  $\text{O}_2$ , how much  $\text{CO}_2$  is produced?
5. How can you tell if a question is a limiting reagent question vs. typical stoichiometry?