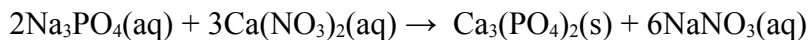


A limiting reactant problem

Sodium phosphate reacts with calcium nitrate in the reaction below.



If you start with 250.g of each reactant in the reaction above, how much $\text{Ca}_3(\text{PO}_4)_2$ can you prepare?

Answer and solution

- You can prepare **158 g** $\text{Ca}_3(\text{PO}_4)_2$.

First, find formula weights of the compounds of interest:

Na_3PO_4	163.94 g/mol
$\text{Ca}(\text{NO}_3)_2$	164.10 g/mol
$\text{Ca}_3(\text{PO}_4)_2$	310.18 g/mol

This is a limiting reactant problem, since we were given amounts of more than one reactant. To solve it, find the amount of $\text{Ca}_3(\text{PO}_4)_2$ that could be produced from each reactant.

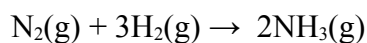
$$250\text{g Na}_3\text{PO}_4 \times \frac{\text{mol}}{163.94\text{g}} \times \frac{1\text{ mol Ca}_3(\text{PO}_4)_2}{2\text{ mol Na}_3\text{PO}_4} \times \frac{310.18\text{g}}{\text{mol}} = 237\text{g Ca}_3(\text{PO}_4)_2$$

$$250\text{g Ca}(\text{NO}_3)_2 \times \frac{\text{mol}}{164.10\text{g}} \times \frac{1\text{ mol Ca}_3(\text{PO}_4)_2}{3\text{ mol Ca}(\text{NO}_3)_2} \times \frac{310.18\text{g}}{\text{mol}} = 158\text{g Ca}_3(\text{PO}_4)_2$$

Since the reaction stops when we run out of one reactant, we can only produce 158g of product. Calcium nitrate is the limiting reactant.

A simple stoichiometry problem

Ammonia (NH₃) can be made from this reaction.



How much hydrogen gas do you need to produce 250.g of NH₃?

Answer and solution

- You need **44.5** g H₂.

Formula weights:

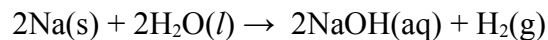
NH ₃	17.03 g/mol
H ₂	2.02 g/mol

This is a simple 3-step stoichiometry problem. Solve with dimensional analysis.

$$250 \text{ g NH}_3 \times \frac{\text{mol}}{17.03 \text{ g}} \times \frac{3 \text{ mol H}_2}{2 \text{ mol NH}_3} \times \frac{2.02 \text{ g}}{\text{mol}} = 44.5 \text{ g H}_2$$

Percent yield problem

Sodium and water react violently to produce sodium hydroxide and hydrogen gas.



If you start with 250.g Na metal and produce 375g NaOH, what is the percent yield of the reaction?

Answer and solution

- The percent yield is **86.2** %.

Formula weights:

Na	22.99 g/mol
NaOH	40.00 g/mol

First, find the theoretical yield using dimensional analysis.

$$250 \text{ g Na} \times \frac{\text{mol}}{22.99 \text{ g}} \times \frac{2 \text{ mol NaOH}}{2 \text{ mol Na}} \times \frac{40.00 \text{ g}}{\text{mol}} = 435 \text{ g NaOH}$$

Then, calculate the percent yield.

$$\frac{375 \text{ g}}{435 \text{ g}} \times 100 \% = 86.2 \%$$