

MODULE 1.10.1: LIMITING REAGENTS

The Reactant That Stops the Reaction



Defining the System Variables

LIMITING REAGENT

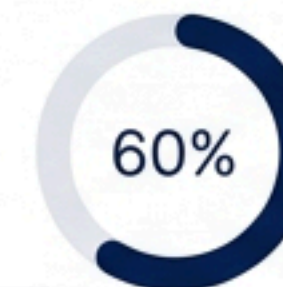


Status at End:
Completely consumed (0% remaining)

Role in Production:
Acts as the bottleneck

Mathematical Function:
Dictates the theoretical yield

EXCESS REAGENT

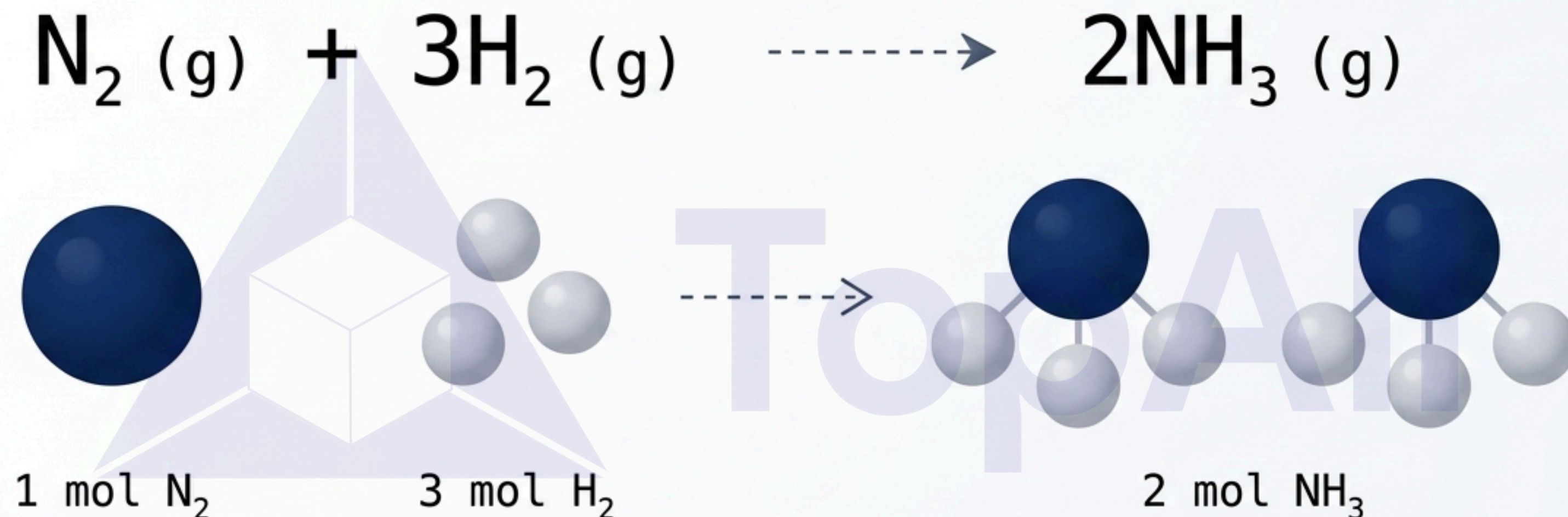


Status at End:
Leftovers remain (>0% remaining)

Role in Production:
Acts as the surplus

Mathematical Function:
Ignored in final yield calculations

The Stoichiometric Blueprint



One part Nitrogen strictly requires three parts Hydrogen to produce two parts Ammonia.



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$$E=mc^2$$



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The Scenario: Industrial Ammonia Synthesis



50.0 kg N_2

Heavy input mass



10.0 kg H_2

Light input mass



Which raw material will be completely consumed first?

Gross tonnage alone cannot answer this.

Diagnostic: Comparing Mole Ratios

$$50.0 \text{ kg N}_2 \rightarrow 17.86 \times 10^2 \text{ mol N}_2$$

$$10.0 \text{ kg H}_2 \rightarrow 4.96 \times 10^3 \text{ mol H}_2$$

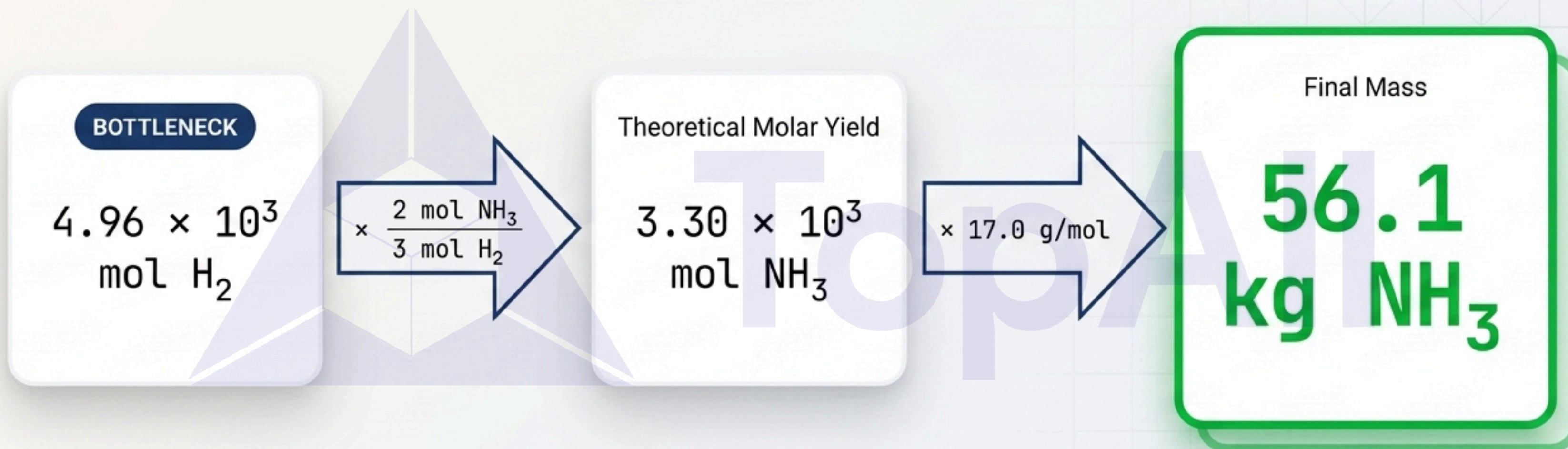
Hydrogen Supply vs. Demand (1:3 Ratio)

Available: $4.96 \times 10^3 \text{ mol H}_2$

DEFICIT DETECTED:
Reaction stops here.

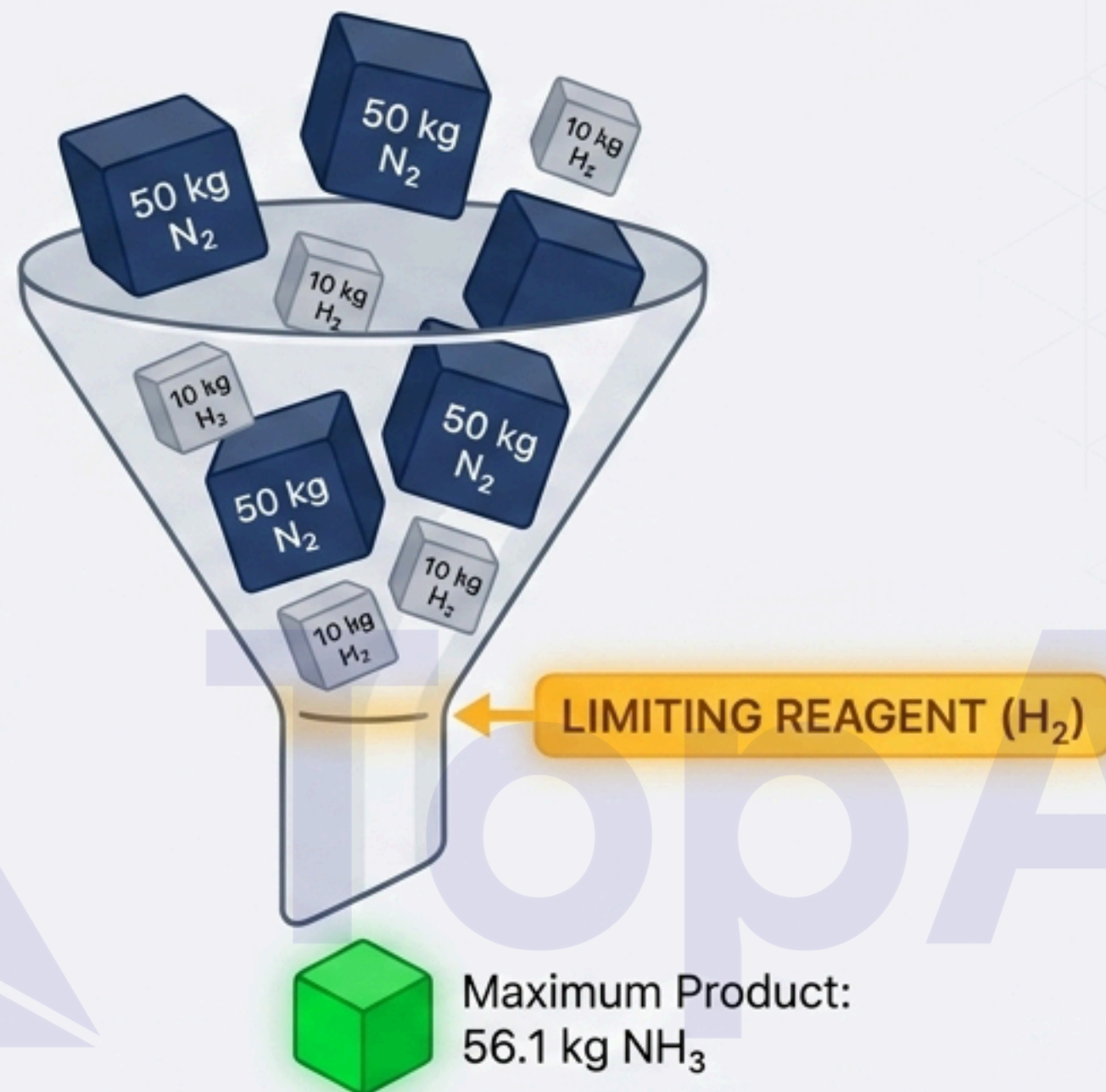
Required: $5.36 \times 10^3 \text{ mol H}_2$

The Verdict: Yield Calculation



Hydrogen restricts the theoretical yield.
The remaining 50.0 kg of Nitrogen is in excess.

Synthesis: Chemistry is Governed by Ratios, Not Tonnage



The maximum theoretical yield is strictly controlled by the reactant that is completely consumed first—regardless of the excess mass of other materials.



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