

# Math Diversion Problem 692: Stoichiometry

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Physical concepts are free creations of the human mind, and  
are not, however it may seem, uniquely determined  
by the external world.  
— Albert Einstein

The problem is found at:

Source: <https://www.youtube.com/watch?v=ymCZ2ShhBAw>

Title: Limiting Reactant 2

Presenter: Chemistry with Melissa Maribel

## 1 Problem



This next problem is taken from *Chemistry with Melissa Maribel*.<sup>1</sup> She also covers the production of ammonia but begins with known masses reactants. I state her version of the problem in paraphrase:

If 14.32 g of  $\text{N}_2$  reacts with 4.21 g of  $\text{H}_2$  to produce  $\text{NH}_3$ , what is the limiting reactant?

First, we repeat the balanced equation of the reaction Eq. (1). Next, we make a diagram with one of the mole counts replaced by a variable.

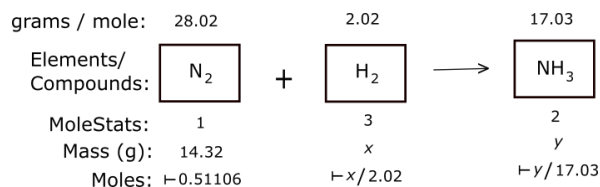


Figure 18. This graphic represents the complete reaction of 14.32 grams of  $\text{N}_2$  with  $x$  grams of  $\text{H}_2$  to produce  $y$  grams of  $\text{NH}_3$ .

<sup>1</sup>Found at <https://www.youtube.com/watch?v=ymCZ2ShhBAw>.

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Next, we write down our mole proportion between columns 1 and 2:

$$\frac{3}{1} = \frac{\text{moles H}_2}{\text{moles N}_2} = \frac{x/2.02}{0.5078} . \quad (2)$$

For which we get  $x = 3.10$  g. So, to use all the nitrogen, we have an excess of hydrogen, which makes the nitrogen the limiting reactant.

To calculate how much ammonia would be produced, we setup another mole proportion, this time between columns 3 and 1:

$$\frac{2}{1} = \frac{\text{moles NH}_3}{\text{moles N}_2} = \frac{y/17.03}{0.51106} , \quad (3)$$

which has solution:  $y = 17.41$  grams.

One last point to make: The YouTube videos revealed to me two different, though equivalent, definitions of *limiting reactant*.

**Definition 1:** The *limiting reactant* is that reactant that is consumed, leaving a portion of the other reactant unconsumed.

**Definition 2:** The *limiting reactant* is that reactant (of only two reactants) which, when fully consumed, produces the lesser amount of product.

Generally, I prefer to use the first definition, but both are useful.

## References

- [1] P. Atkins and L. Jones. *Chemical Principles: The Quest for Insight*, 3rd Ed. Freeman (2005).
- [2] R. Blitzer. *Intermediate Algebra for College Students*, 3rd Ed. Prentice-Hall (2002).
- [3] M. Hein and S. Arena *Foundations of College Chemistry*, alternate 12th ed, John Wiley & Sons (2007), 421–422.
- [4] H. Rolf. *Finite Mathematics*, 5th Ed. Brooks/Cole (2002), p. 57.
- [5] M. S. Silberberg. *Chemistry: The Molecular Nature of Matter and Change* 4th Ed. McGraw-Hill (2006).