Math Diversion Problem 881

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The trick is to recognize when you have a special case at hand.
— the Author

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Source:  https://www.alvinisd.net/cms/lib03/TX01001897/Centricity
                 /Domain/4240/practice%20test%20stoich.pdf
Title: From an online stoichiometry practice test
  Presenter:  Patrick
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1 Problem

#7. How many grams of nitric acid, HNO_3, can be prepared from the reaction of 138 g of NO_2 with 54.0 g H_2O according to the equation below?

$$3NO_2 + H_2O \longrightarrow 2HNO_3 + NO \tag{1}$$

a. 92 b. 108 c. 126 d. 189 e. 279 .

2 Solution

Step 1: We'll begin by treating this as a limiting reactant type problem.
Let's make a stoich diagram to help out.

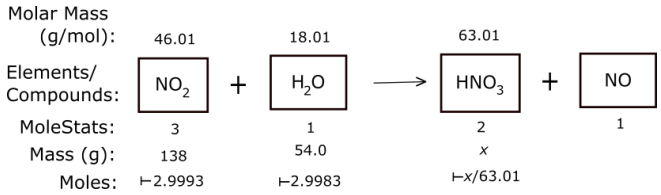

Figure 1. The problem told us that we have 54.0 grams of H_2O to use. Let's see if that's enough or too much.

Our first task is to decide which of the reactants is limiting. Say, we consume all the H_2O in the reaction. How much NO_2 would we need? From the Molestats

line we see that for each mole of H_2O used, we need 3 moles of NO_2, but this obviously won't work. So, the NO_2 is the limiting reactant.

Therefore we assume that we use all the NO_2 and form the mole proportion for columns 3 and 1:

$$\frac{2}{3} = \frac{\text{moles } HNO_3}{\text{moles } NO_2} = \frac{x/63.01}{2.9993}\,. \tag{2}$$

Solving for x, we get about 126 grams, which is answer c.

3 Appendix: How to interpret the Stoich diagrams

There are four main types of data in the stoich diagrams I make. The most common are data from given information, from the coefficients of the balanced equation, and from data tables, such as a periodic table of elements for molar mass information. This kind of data I do not mark up. The second kind of data in stoich diagrams comes from computations based on data in the same column, for which I use the turnstile ($\vdash$) to indicate. The third kind of data is a result in one column that required data from at least one other column to calculate it, and I indicate that kind of value or result by use of the underlining. The fourth kind of data in the figures is the result of combining given information to derive a secondary value. I indicate this kind of data with a right arrowhead ($\blacktriangleright$).