

Math Diversion Problem 889

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The human mind has never invented a labor-saving
machine equal to algebra.
— J. Willard Gibbs

Source: <https://www.youtube.com/watch?v=e7M0JiJZSiQ>

Title: A Gravimetric Analysis Problem 4

Presenter: Patrick

1 Problem

Definitions:

FW = Formula weight = molar mass

ppt = precipitate

At wt = atomic weight

2 Problem

PROBLEM:

An unknown metal cation has a +1 charge (M^+). The bromide of the unknown metal, MBr, is dissolved in enough water to make 100.0 mL of solution. The solution is then mixed with an excess of $AgNO_3$ solution to precipitate AgBr (molar mass = 188 g/mol). The precipitate is collected by filtration, dried, and the following data was obtained:

Mass of MBr = 1.38 g

Mass of filter paper = 0.98 g

Mass of filter paper and AgBr = 2.86 g

What is the identity of the metal chloride?

a) KBr b) NiBr c) LiBr d) NaBr

Ans: b).

SOLUTION:

Step 1. Prepare data needed for the stoich diagram.

From the given information, we can derive the mass of the AgBr

$$\text{mass AgBr} = (\text{mass filter paper} + \text{AgBr}) - (\text{mass filter paper}) = 1.88 \text{ g}. \quad (1)$$

When this mass information is placed in the stoich diagram, it will be preceded by a ► symbol to inform the reader that the information was derived, not given or looked up in a reference source.

Step 2. Make a stoich diagram.

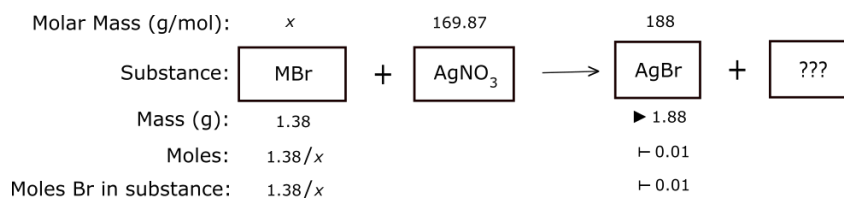


Figure 1. Once we know x , we can determine from a periodic table what M stands for. The turnstile means ‘is calculated from information only in the same column’. The solid right arrowhead means ‘is a derivative result of the given information or some other source’.

Step 3.

Now, equating the moles of Br in columns 1 and 3, and solving for x , we get at about $138 \text{ g}\cdot\text{mol}^{-1}$, of which $79.90 \text{ g}\cdot\text{mol}^{-1}$ is from the bromine. The difference, then, is approximately the molar mass of M, namely, $58.1 \text{ g}\cdot\text{mol}^{-1}$. Therefore, the mystery element must be nickel, making b) the answer.

3 Appendix

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 (┌) 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 (►).