Math Diversion Problem 915

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Source:  https://www.calstatela.edu/sites/default/files/dept/
            chem/07winter/201-lec/201-l-4-gravimetric
              -analysis.pdf (p.\ 9)
 Title: Precipitating Silver
  Presenter: Patrick
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1 Problem

How many mL of 1% potassium chloride would be needed to precipitate all of the silver in a 0.5 g ore sample that contains 1.5 parts per thousand silver? Allow for 50% excess of the chloride solution.

2 Solution

Step 1. First we calculate the mass of the silver in the ore sample:

$$\text{mass of Ag} = \frac{1.5}{1000} \times 0.5\,\text{g} = 7.5 \times 10^{-4}\,\text{g}\,. \tag{1}$$

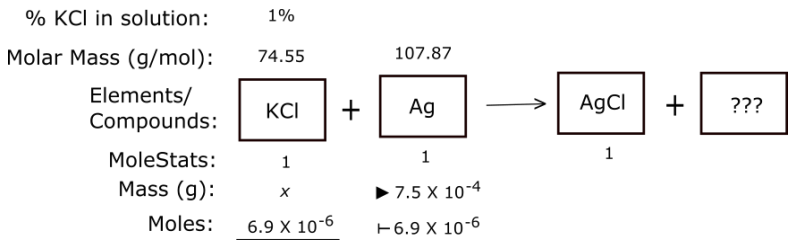

Figure 1. In column 2, the mass of the silver is a derivative result, calculated from the given data. Then the moles of Ag is easily calculated. Then, by column hopping, the moles of KCl is calculated by one-to-one molar correspondence between columns 1 and 2.

Step 2. Now, a diagram showing the replacement of the potassium (K) in KCl by Silver (Ag) to form the precipitate silver chloride (AgCl).

Step 3.

We can calculate x in column 1:

$$x = (6.9 \times 10^{-6}\,\text{moles})(74.55\,\text{g}\cdot\text{mol}^{-1}) = 5.14 \times 10^{-4}\,\text{g}\,. \tag{2}$$

Now, 1% KCl solution by mass is formed by taking one part KCl to 99 parts water. Since 1 gram of water is 1 mL water,[1] the volume V needed is given by

$$V = \frac{5.14 \times 10^{-4}\,\text{g KCl}}{1\,\text{g KCl}/99\,\text{mL H}_2\text{O}} = 0.0509\,\text{mL [solution]}\,. \tag{3}$$

Now, adding another 50% to that volume yields $V = 0.0764\,\text{mL}$.

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 ($\blacktriangleright$).

[1] This is true to a very close approximation.