Math Diversion Problem 883

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> I feel that a visual representation of the Dirac algebra is of great benefit, because it can provide an additional insight that is not easily expressed with words or equations.
> — David M. Goodmanson
> ['A graphical representation of the Dirac algebra',
> American J. Phys., Vol. 64, No. 7,
> July 1996, p. 870.]

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Source:     https://www.youtube.com/watch?v=e7M0JiJZSiQ
Title: A Gravimetric Analysis Problem
  Presenter:  Patrick
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1 Problem

A 10.500 gram mixture contains calcium nitrate and potassium chloride. Excess lead (II) nitrate solution, $Pb(NO_3)_2\,(aq)$, is added to precipitate out 4.227 grams of lead (II) chloride, $PbCl_2\,(s)$. What percent by mass of potassium chloride is in the mixture?

SOLUTION: Step 1.

We'll begin with the equation that deals with the precipitation:

$$2KCl(aq) + Pb(NO_3)_2(aq) \longrightarrow PbCl_2(s) + 2KNO_3(aq)\,. \tag{1}$$

Let's make a stoich diagram to help out.

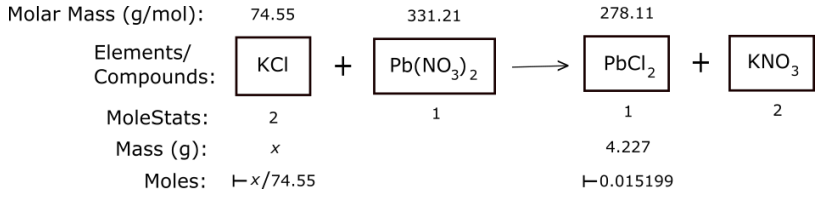

Figure 5. Lead (II) chloride ($PbCl_2$) is one of the few insoluble chlorides.

Next, we write down our mole proportion for the two compounds of interest from columns 1 and 3:

$$\frac{2}{1} = \frac{\text{moles KCl}}{\text{moles PbCl}_2} = \frac{x/74.55\,\text{g·mol}^{-1}}{0.015199\,\text{mol}}\,. \tag{2}$$

Which gives for x about 2.226 grams. Thus, the percent by mass of the KCl in the original mixture is

$$\frac{2.226}{10.500} \times 100\% = 21.6\% \tag{3}$$

Answer given: 21.6%.

2 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 (⊢) 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 (▶).