

Math 221: LINEAR ALGEBRA

Chapter 1. Systems of Linear Equations §1-6. Application to Chemical Reactions

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¹Slides are adapted from those by Karen Seyffarth from University of Calgary.

Linear Algebra with Applications

Lecture Notes

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These lecture notes were originally developed by Karen Seyffarth of the University of Calgary. Edits, additions, and revisions have been made to these notes by the editorial team at Lyryx Learning to accompany their text [Linear Algebra with Applications](#) based on W. K. Nicholson's original text.

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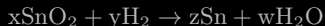
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Chemical Reactions

Balancing Chemical Reactions

Problem

Balance the chemical reaction given below involving tin (Sn), hydrogen (H), and oxygen (O).



Solution

Setting up a system of equations in x, y, z, w gives

$$\text{Sn} \quad : \quad x = z \text{ or } x - z = 0$$

$$\text{O} \quad : \quad 2x = w \text{ or } 2x - w = 0$$

$$\text{H} \quad : \quad 2y = 2w \text{ or } 2y - 2w = 0$$

The augmented matrix is
$$\left[\begin{array}{cccc|c} 1 & 0 & -1 & 0 & 0 \\ 2 & 0 & 0 & -1 & 0 \\ 0 & 2 & 0 & -2 & 0 \end{array} \right]$$

Solution (continued)

The reduced row-echelon matrix is

$$\left[\begin{array}{cccc|c} 1 & 0 & 0 & -\frac{1}{2} & 0 \\ 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & 1 & -\frac{1}{2} & 0 \end{array} \right]$$

Letting $w = t$, the solution is

$$x = \frac{1}{2}t$$

$$y = t$$

$$z = \frac{1}{2}t$$

$$w = t$$

We can choose any values for $w = t$. Suppose we choose $w = 4$, then $x = 2, y = 4, z = 2$ and the balanced reaction is

