

# Math 221: LINEAR ALGEBRA

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

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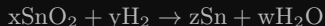
<sup>1</sup>Slides are adapted from those by Karen Seyffarth from University of Calgary.

## 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

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

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

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

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

$$\begin{aligned} x &= \frac{1}{2}t \\ y &= t \\ z &= \frac{1}{2}t \\ w &= t \end{aligned}$$

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

