Here are two matrices:

$$P = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \qquad Q = \begin{bmatrix} 2a & 2b \\ c & d \end{bmatrix}.$$

Suppose that $\begin{bmatrix} w \\ x \end{bmatrix}$ is an output of P.

- Which of the following is definitely an output of Q:

$$\begin{bmatrix} w \\ x \end{bmatrix} \qquad \begin{bmatrix} 2w \\ x \end{bmatrix} \qquad \begin{bmatrix} w \\ 2x \end{bmatrix} \qquad \begin{bmatrix} 2w \\ 2x \end{bmatrix}?$$

- Suppose that $P\begin{bmatrix} y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$. Which of the following is definitely true:

$$Q\begin{bmatrix} y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad Q\begin{bmatrix} 2y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad Q\begin{bmatrix} y \\ 2z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad Q\begin{bmatrix} 2y \\ 2z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}?$$

Here is another matrix:

$$R = \begin{bmatrix} 2a & b \\ 2c & d \end{bmatrix}.$$

- Which of the following is definitely an output of R:

$$\begin{bmatrix} w \\ x \end{bmatrix} \qquad \begin{bmatrix} 2w \\ x \end{bmatrix} \qquad \begin{bmatrix} w \\ 2x \end{bmatrix} \qquad \begin{bmatrix} 2w \\ 2x \end{bmatrix}?$$

- Which of the following is definitely true:

$$R\begin{bmatrix} y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad R\begin{bmatrix} 2y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad R\begin{bmatrix} y \\ 2z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad R\begin{bmatrix} 2y \\ 2z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}?$$