12.10.3.17

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CLASS 12, CHAPTER 10, EXERCISE 4.8

8) If either $\mathbf{a} = 0$ or $\mathbf{b} = 0$ then $\mathbf{a} \times \mathbf{b} = 0$. Is the converse true? Justify your answer with an example.

Solution: False.

Let $\mathbf{a} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$ and $\mathbf{b} = \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}$.

Here neither of $\mathbf{a}$ or $\mathbf{b}$ is zero.

$$\mathbf{a} \times \mathbf{b} = \begin{pmatrix} \begin{vmatrix} \mathbf{a}_{23} & \mathbf{b}_{23} \\ \mathbf{a}_{31} & \mathbf{b}_{31} \\ \mathbf{a}_{12} & \mathbf{b}_{12} \end{vmatrix} \end{pmatrix} \tag{1}$$

Hence

$$\begin{vmatrix} \mathbf{a}_{23} & \mathbf{b}_{23} \end{vmatrix} = \begin{vmatrix} 0 & 0 \\ 0 & 0 \end{vmatrix} = 0 \tag{2}$$

$$\begin{vmatrix} \mathbf{a}_{31} & \mathbf{b}_{31} \end{vmatrix} = \begin{vmatrix} 0 & 0 \\ 1 & 2 \end{vmatrix} = 0 \tag{3}$$

$$\begin{vmatrix} \mathbf{a}_{12} & \mathbf{b}_{12} \end{vmatrix} = \begin{vmatrix} 1 & 2 \\ 0 & 0 \end{vmatrix} = 0 \tag{4}$$

Substituting in the above equation, we get

$$\mathbf{a} \times \mathbf{b} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \tag{5}$$

$$\tag{6}$$

Justfied.