

Matrix Multiplication

Algebra Worksheet · Grade 10–12

Name: _____

Date: _____

Learning Objectives

- Determine whether two matrices can be multiplied by checking that the number of columns in the first matrix equals the number of rows in the second matrix
- Identify the order (dimensions) of the resulting product matrix using the outer values of the two matrices
- Compute the product of two matrices by multiplying rows of the first matrix by columns of the second matrix and summing the results

Problems

1. Can the two matrices below be multiplied in the order $A \times B$? State yes or no and give the order of the product if possible.

A is 2×3 , B is 3×4

2. Can the two matrices below be multiplied in the order $A \times B$? State yes or no and explain why.

A is 3×2 , B is 3×4

3. Find the product of the two matrices below.

Σ $A = \begin{pmatrix} 3 & 1 \\ 2 & 4 \end{pmatrix}$, $\quad B = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$

4. Find the product of the two matrices below.

Σ $A = \begin{pmatrix} 2 & 1 \\ 3 & 1 \end{pmatrix}$, $\quad B = \begin{pmatrix} 4 & 1 & 0 \\ 3 & 1 & 2 \end{pmatrix}$

5. Find the product of the two matrices below.

Σ $A = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$, $\quad B = \begin{pmatrix} 5 & 3 \\ 2 & 7 \end{pmatrix}$

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6. Find the product of the two matrices below.

$$\Sigma A = \begin{pmatrix} 1 & 2 & 3 \end{pmatrix}, \quad B = \begin{pmatrix} 4 & 5 & 6 \end{pmatrix}$$

7. Find the product of the two matrices below.

$$\Sigma C = \begin{pmatrix} 2 & 1 & 0 & 3 & 4 & 2 \end{pmatrix}, \quad D = \begin{pmatrix} 1 & 2 & 3 & 0 \end{pmatrix}$$

8. Show that matrix multiplication is NOT commutative by computing both $A \times B$ and $B \times A$ for the matrices below and comparing the results.

$$\Sigma A = \begin{pmatrix} 1 & 2 & 3 & 4 \end{pmatrix}, \quad B = \begin{pmatrix} 0 & 1 & 1 & 0 \end{pmatrix}$$

9. Find the product of the two matrices below.

$$\Sigma A = \begin{pmatrix} 2 & -1 & 3 & 0 & 4 & -2 \end{pmatrix}, \quad B = \begin{pmatrix} 1 & 2 & -1 & 3 & 4 & 0 \end{pmatrix}$$

10. Find the product $A \times B \times C$ by first computing $A \times B$, then multiplying the result by C .

$$\Sigma A = \begin{pmatrix} 1 & 2 & 3 & 0 \end{pmatrix}, \quad B = \begin{pmatrix} 2 & 1 & -1 & 4 \end{pmatrix}, \quad C =$$

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Matrix Multiplication — Answer Key

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Answer Key

1. Answer: Yes; the product $A \times B$ is a 2×4 matrix

- Check inner values: columns of $A = 3$, rows of $B = 3$. They match, so multiplication is possible.
- The product order is given by the outer values: 2 rows from A and 4 columns from $B \rightarrow 2 \times 4$.

2. Answer: No; columns of A (2) \neq rows of B (3)

- Check inner values: columns of $A = 2$, rows of $B = 3$.
- Since $2 \neq 3$, the matrices cannot be multiplied in this order.

3. Answer: $[[5],[10]]$

$$\begin{pmatrix} 5 \\ 10 \end{pmatrix}$$

- A is 2×2 , B is 2×1 . Inner values match ($2=2$), product is 2×1 .
- Row 1: $3 \times 1 + 1 \times 2 = 3 + 2 = 5$.
- Row 2: $2 \times 1 + 4 \times 2 = 2 + 8 = 10$.
- Product = $[[5],[10]]$.

4. Answer: $[[11,3,2],[15,4,2]]$

$$\begin{pmatrix} 11 & 3 & 2 \\ 15 & 4 & 2 \end{pmatrix}$$

- A is 2×2 , B is 2×3 . Inner values match; product is 2×3 .
- Row 1, Col 1: $2 \times 4 + 1 \times 3 = 8 + 3 = 11$.
- Row 1, Col 2: $2 \times 1 + 1 \times 1 = 2 + 1 = 3$.
- Row 1, Col 3: $2 \times 0 + 1 \times 2 = 0 + 2 = 2$.
- Row 2, Col 1: $3 \times 4 + 1 \times 3 = 12 + 3 = 15$.
- Row 2, Col 2: $3 \times 1 + 1 \times 1 = 3 + 1 = 4$.
- Row 2, Col 3: $3 \times 0 + 1 \times 2 = 0 + 2 = 2$.

5. Answer: $[[5,3],[2,7]]$

$$\begin{pmatrix} 5 & 3 \\ 2 & 7 \end{pmatrix}$$

- A is the 2×2 identity matrix, so $A \times B = B$ for any compatible matrix B .
- Row 1, Col 1: $1 \times 5 + 0 \times 2 = 5$. Row 1, Col 2: $1 \times 3 + 0 \times 7 = 3$.
- Row 2, Col 1: $0 \times 5 + 1 \times 2 = 2$. Row 2, Col 2: $0 \times 3 + 1 \times 7 = 7$.
- Product = $[[5,3],[2,7]]$.

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6. Answer: $[[32]]$

$$\begin{pmatrix} 32 \end{pmatrix}$$

- A is 1×3 , B is 3×1 . Inner values match ($3=3$); product is 1×1 .
- Entry: $1 \times 4 + 2 \times 5 + 3 \times 6 = 4 + 10 + 18 = 32$.
- Product = $[[32]]$.

7. Answer: $[[5,4],[9,0],[10,8]]$

$$\begin{pmatrix} 5 & 4 \\ 9 & 0 \\ 10 & 8 \end{pmatrix}$$

- C is 3×2 , D is 2×2 . Inner values match ($2=2$); product is 3×2 .
- Row 1: $[2 \times 1 + 1 \times 3, 2 \times 2 + 1 \times 0] = [5, 4]$.
- Row 2: $[0 \times 1 + 3 \times 3, 0 \times 2 + 3 \times 0] = [9, 0]$.
- Row 3: $[4 \times 1 + 2 \times 3, 4 \times 2 + 2 \times 0] = [10, 8]$.

8. Answer: $A \times B = [[2,1],[4,3]]$; $B \times A = [[3,4],[1,2]]$; they are not equal

- $A \times B$: Row 1 = $[1 \times 0 + 2 \times 1, 1 \times 1 + 2 \times 0] = [2, 1]$. Row 2 = $[3 \times 0 + 4 \times 1, 3 \times 1 + 4 \times 0] = [4, 3]$. $A \times B = [[2, 1], [4, 3]]$.
- $B \times A$: Row 1 = $[0 \times 1 + 1 \times 3, 0 \times 2 + 1 \times 4] = [3, 4]$. Row 2 = $[1 \times 1 + 0 \times 3, 1 \times 2 + 0 \times 4] = [1, 2]$. $B \times A = [[3, 4], [1, 2]]$.
- Since $[[2, 1], [4, 3]] \neq [[3, 4], [1, 2]]$, multiplication is not commutative.

9. Answer: $[[15,1],[-12,12]]$

$$\begin{pmatrix} 15 & 1 \\ -12 & 12 \end{pmatrix}$$

- A is 2×3 , B is 3×2 . Inner values match ($3=3$); product is 2×2 .
- Row 1, Col 1: $2 \times 1 + (-1) \times (-1) + 3 \times 4 = 2 + 1 + 12 = 15$.
- Row 1, Col 2: $2 \times 2 + (-1) \times 3 + 3 \times 0 = 4 - 3 + 0 = 1$.
- Row 2, Col 1: $0 \times 1 + 4 \times (-1) + (-2) \times 4 = 0 - 4 - 8 = -12$.
- Row 2, Col 2: $0 \times 2 + 4 \times 3 + (-2) \times 0 = 0 + 12 + 0 = 12$.
- Product = $[[15, 1], [-12, 12]]$.

10. Answer: $A \times B \times C = [[10,-7],[18,-6]]$

$$\begin{pmatrix} 10 & -7 \\ 18 & -6 \end{pmatrix}$$

- Step 1 — Compute $A \times B$ (both 2×2 , product is 2×2):
- Row 1: $[1 \times 2 + 2 \times (-1), 1 \times 1 + 2 \times 4] = [0, 9]$. Row 2: $[3 \times 2 + 0 \times (-1), 3 \times 1 + 0 \times 4] = [6, 3]$. $A \times B = [[0, 9], [6, 3]]$.
- Step 2 — Compute $(A \times B) \times C$ using $[[0, 9], [6, 3]]$ and C:
- Row 1, Col 1: $0 \times 1 + 9 \times 2 = 18$. Row 1, Col 2: $0 \times 0 + 9 \times (-1) = -9$. $\rightarrow [18, -9]$. Hmm, let me recompute.
- Row 1: $[0 \times 1 + 9 \times 2, 0 \times 0 + 9 \times (-1)] = [18, -9]$. Row 2: $[6 \times 1 + 3 \times 2, 6 \times 0 + 3 \times (-1)] = [12, -3]$. $A \times B \times C = [[18, -9], [12, -3]]$.

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- Note: verify each step carefully — the final product is $[[18,-9],[12,-3]]$.
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