

10-2

Matrix Multiplication

 PearsonRealize.com

EXPLORE & REASON

Two stores, Quick Repair and TechRite, buy and sell pre-owned phones, tablets, and computers. The matrices below represent their average revenue R , purchase costs C , and repair expenses E for each item:



R	Quick Repair	\$150	\$100	\$400
	TechRite	\$200	\$250	\$500

C	Quick Repair	\$100	\$50	\$200
	TechRite	\$125	\$75	\$300

E	Quick Repair	\$25	\$20	\$50
	TechRite	\$10	\$50	\$50

A. Would it make sense to find the sum and/or difference of any two of the three matrices? Explain.

B. **Make Sense and Persevere** Quick Repair and TechRite both need to estimate their total purchase and repair costs. They each predict that they will need to purchase 100 phones, 100 tablets, and 100 computers, and that they will need to repair 50% of them. Explain what you would do to find the total costs. © MP.1

HABITS OF MIND

Reason Which store makes a greater profit from the sale of a repaired phone? Explain. © MP.2

**EXAMPLE 1** **Try It!** Understand Matrix Multiplication

1. How would the matrices need to change to determine GW instead of WG ?

EXAMPLE 2 **Try It!** Examine Multiplication of Square Matrices

2. Determine whether each equation may be true for the following matrices.

$$A = \begin{bmatrix} 3 & 0 \\ -1 & -2 \end{bmatrix}, B = \begin{bmatrix} -2 & 1 \\ 3 & -4 \end{bmatrix}, C = \begin{bmatrix} 6 & 2 \\ 4 & 8 \end{bmatrix}$$

a. $(AB)C = A(BC)$

b. $(A + B)C = AC + BC$

HABITS OF MIND

Construct Arguments Let $M = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$ and $N = \begin{pmatrix} -2 & 1 \\ 1.5 & -0.5 \end{pmatrix}$. Is $MN = NM$?
If so, can you conclude that matrix multiplication is commutative? © MP.3



**EXAMPLE 3** **Try It! Understand Identity Matrices**

3. a. What is the product of $\begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$?

b. What is the product of $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$?

HABITS OF MIND

Use Structure Let $A = \begin{bmatrix} -1 & 0 \\ 3 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} j & k \\ l & m \end{bmatrix}$. $AB = \begin{bmatrix} -1 & 0 \\ 3 & 5 \end{bmatrix}$. What are the values of j , k , l , and m ? © MP.7



Do You UNDERSTAND?

1. **ESSENTIAL QUESTION** What does it mean to multiply a matrix by another matrix?

2. **Reason** Would it be possible to multiply $A_{3 \times 5}$ and $B_{4 \times 5}$? Explain your reasoning. © MP.2

3. **Vocabulary** Explain why a matrix with ones on the main diagonal and zeros for all the other elements is called the *identity matrix*.

4. **Error Analysis** A student thought that the product of $A_{1 \times 5}$ and $B_{5 \times 1}$ should have five elements in the answer. Is the student correct? If not, how many elements will there be? © MP.3

Do You KNOW HOW?

Let $A = \begin{bmatrix} 3 & 0 \\ -1 & -2 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & 1 \\ 3 & -4 \end{bmatrix}$.

5. Find AB and BA to demonstrate that matrix multiplication is not commutative. Show your work.

Find each product.

6. $\begin{bmatrix} 4 & 7 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

7. $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 5 & 0 \\ 8 & 2 \end{bmatrix}$

8. The coordinates of the vertices of a triangle are $A(-2, 3)$, $B(1, 1)$, and $C(2, -1)$. The coordinates are multiplied by the matrix $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$. Find the coordinates of the image of the triangle after the transformation.

