Matrix Operations

1. What size is this matrix?

$$\begin{bmatrix} 6 & 11 & -2 \\ 23 & 31 & 5 \end{bmatrix}$$

   (a) 2x3

   (b) 3x2

   (c) 6

2. Let $A = \begin{bmatrix} 4 & 6 \\ 20 & 24 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 5 \\ 3 & 7 \end{bmatrix}$

   What is $A + B$?

   (a) 71

   (b) $\begin{bmatrix} 6 & 9 \\ 7 & 11 \end{bmatrix}$

   (c) $\begin{bmatrix} 6 & 11 \\ 23 & 31 \end{bmatrix}$

   (d) $\begin{bmatrix} 26 & 62 \\ 112 & 268 \end{bmatrix}$

   (e) $\begin{bmatrix} 4 & 6 & 2 & 5 \\ 20 & 24 & 3 & 7 \end{bmatrix}$

3. If $A = \begin{bmatrix} 2 & 3 & 1 \\ 0 & -1 & 3 \\ -2 & 0 & 4 \end{bmatrix}$ what is A^T?

   (a) $A^T = \begin{bmatrix} 2 & 3 & 1 \\ 0 & -1 & 3 \\ -2 & 0 & 4 \end{bmatrix}$

   (b) $A^T = \begin{bmatrix} 2 & 0 & -2 \\ 3 & -1 & 0 \\ 1 & 3 & 4 \end{bmatrix}$

(c) $A^T = \begin{bmatrix} -2 & 0 & 4 \\ 0 & -1 & 3 \\ 2 & 3 & 1 \end{bmatrix}$

(d) $A^T = \begin{bmatrix} 1 & 3 & 4 \\ 3 & -1 & 0 \\ 2 & 0 & -2 \end{bmatrix}$

4. If $A = \begin{bmatrix} 4 & 6 \\ 20 & 7 \end{bmatrix}$ what is $5A$?

   (a) $5A = \begin{bmatrix} 9 & 6 \\ 20 & 7 \end{bmatrix}$

   (b) $5A = \begin{bmatrix} 9 & 11 \\ 25 & 12 \end{bmatrix}$

   (c) $5A = \begin{bmatrix} 20 & 6 \\ 20 & 7 \end{bmatrix}$

   (d) $5A = \begin{bmatrix} 20 & 30 \\ 100 & 35 \end{bmatrix}$

5. If A is a matrix and c a scalar such that $cA = 0$ (here 0 represents a matrix with all entries equal to zero), then

   (a) A is the identity matrix.

   (b) $A = 0$

   (c) $c = 0$

   (d) Both $A = 0$ and $c = 0$

   (e) Either $A = 0$ or $c = 0$

   (f) We can't deduce anything.

6. If $A = \begin{bmatrix} 2 & 1 \\ 3 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 4 \\ -1 \end{bmatrix}$ then calculate the product AB.

   (a) $AB = \begin{bmatrix} 5 \\ 2 \end{bmatrix}$

   (b) $AB = \begin{bmatrix} 10 & 7 \end{bmatrix}$

   (c) $AB = \begin{bmatrix} 8 & 4 \\ -3 & -2 \end{bmatrix}$

   (d) $AB = \begin{bmatrix} 7 \\ 10 \end{bmatrix}$

(e) None of the above.

(f) This matrix multiplication is impossible.

7. Calculate $\begin{bmatrix} 2 & 0 \\ -3 & 1 \end{bmatrix} \times \begin{bmatrix} 0 & -1 \\ 2 & 2 \end{bmatrix}$.

(a) $\begin{bmatrix} 3 & -1 \\ -2 & 2 \end{bmatrix}$

(b) $\begin{bmatrix} 0 & -2 \\ 2 & 5 \end{bmatrix}$

(c) $\begin{bmatrix} 0 & 0 \\ -6 & 2 \end{bmatrix}$

(d) None of the above.

(e) This matrix multiplication is impossible.

8. Calculate $\begin{bmatrix} 0 & -1 \\ 2 & 2 \end{bmatrix} \times \begin{bmatrix} 2 & 0 \\ -3 & 1 \end{bmatrix}$.

(a) $\begin{bmatrix} 3 & -1 \\ -2 & 2 \end{bmatrix}$

(b) $\begin{bmatrix} 0 & -2 \\ 2 & 5 \end{bmatrix}$

(c) $\begin{bmatrix} 0 & 0 \\ -6 & 2 \end{bmatrix}$

(d) None of the above.

(e) This matrix multiplication is impossible.

9. **True or False** If A and B are square matrices with the same dimensions, then $(A + B) \times (A + B) = A^2 + 2AB + B^2$.

(a) True, and I am very confident

(b) True, but I am not very confident

(c) False, but I am not very confident

(d) False, and I am very confident

10. If A and B are both 2x3 matrices, then which of the following is not defined?

(a) $A + B$

(b) $A^T B$

(c) BA

(d) AB^T

(e) More than one of the above

(f) All of these are defined.

11. If A is a 2x3 matrix and B is a 3x6 matrix, what size is AB?

(a) 2x6

(b) 6x2

(c) 3x3

(d) 2x3

(e) 3x6

(f) This matrix multiplication is impossible.

12. In order to compute the matrix product AB, what must be true about the sizes of A and B?

(a) A and B must have the same number of rows.

(b) A and B must have the same number of columns.

(c) A must have as many rows as B has columns.

(d) A must have as many columns as B has rows.

13. If $A = \begin{bmatrix} 2 & 3 & 1 \\ 0 & -1 & 3 \\ -2 & 0 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 0 & 2 \\ 1 & 2 & -1 \\ 3 & 1 & 0 \end{bmatrix}$ what is the (3,2)-entry of AB? (You should be able to determine this without computing the entire matrix product.)

(a) 1

(b) 3

(c) 4

(d) 8

14. You have a business that sells tables and chairs. You have brown tables and white tables, and corresponding chairs. Your May sales are 4 brown tables, 6 white tables, 20 brown chairs, and 24 white chairs, which is represented by the matrix $M = \begin{bmatrix} 4 & 6 \\ 20 & 24 \end{bmatrix}$. where the first row is tables, the second row is chairs, the first column is brown items, and the second column is white items. If your October sales are 50% more than your May sales, which of the following would represent your October sales?

    (a) $M + 50$
    (b) $0.5M$
    (c) $1.5M$
    (d) $M^{.5}$

15. You have a business that sells tables and chairs. You have brown tables and white tables, and corresponding chairs. Your May sales are 4 brown tables, 6 white tables, 20 brown chairs, and 24 white chairs, which is represented by the matrix $M = \begin{bmatrix} 4 & 6 \\ 20 & 24 \end{bmatrix}$. where the first row is tables, the second row is chairs, the first column is brown items, and the second column is white items. Your June sales are given by the analogous matrix J, where $J = \begin{bmatrix} 6 & 8 \\ 22 & 32 \end{bmatrix}$. Which of the following matrix operations would make sense in this scenario? Be prepared to explain what the result tells you.

    (a) $M + J$
    (b) $M - J$
    (c) $1.2J$
    (d) MJ
    (e) All of the above make sense.
    (f) More than one, but not all, of the above make sense.

16. You have a business that sells tables and chairs. You have brown tables and white tables, and corresponding chairs. Your May sales are 4 brown tables, 6 white tables, 20 brown chairs, and 24 white chairs, which is represented by the matrix $M = \begin{bmatrix} 4 & 6 \\ 20 & 24 \end{bmatrix}$. where the first row is tables, the second row is chairs, the first column is brown items, and the second column is white items. All tables cost \$350 and all chairs cost \$125, which we represent with the cost vector $C = \begin{bmatrix} 350 \\ 125 \end{bmatrix}$. Which of the following matrix operations could be useful in this scenario? Be prepared to explain what the result tells you.

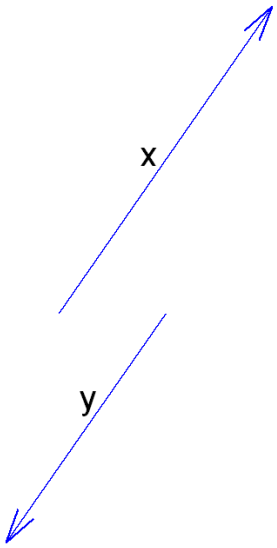
    (a) MC

(b) CM

(c) $C^T M$

(d) MC^T

17. **True or False** Given the vectors x and y plotted below and some matrix A, if we know that $Ax = 0$, this means that $Ay = 0$ as well.



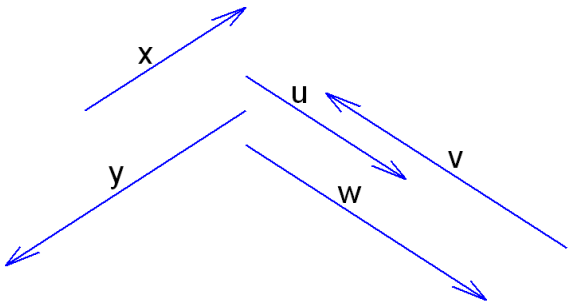
(a) True, and I am very confident

(b) True, but I am not very confident

(c) False, but I am not very confident

(d) False, and I am very confident

18. Given the vectors x, y, u, v, and w plotted below and some matrix A, if we know that $Ax = u$, what does this tell us about the product Ay?



(a) $Ay = u$

(b) $Ay = v$

(c) $Ay = w$

(d) We cannot say anything about Ay without knowing more about A.

19. Let A, B, C be 3 matrices such that the product ABC is defined. What is $(ABC)^T$?

(a) $(ABC)^T = A^T B^T C^T$

(b) $(ABC)^T = B^T C^T A^T$

(c) $(ABC)^T = C^T A^T B^T$

(d) $(ABC)^T = C^T B^T A^T$