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MATRICES

A Matrix is simplified version of working with equations with multiple variables.

If a car company is building cars and trucks they can use matrices to determine the number of parts they will need over a given span of time, producing a particular number of vehicles. If each car needs 4 wheels, 2 bench seats, and 1 gas tank. Each truck needs 6 wheels, 1 bench seat and 3 gas tanks. Then we can set-up a matrix where each row and column are for a given part of the equation.

$$\begin{matrix} & w & s & g \\ c & 4 & 2 & 1 \\ t & 6 & 1 & 3 \end{matrix}$$, where the c=cars, t=trucks, w=wheels, s=seats, and g=gas tanks

Using matrices we can solve for all kinds of situations. Matrices have their own specific rules for adding, subtracting, multiplying, and dividing.

The size (dimension) of a Matrix is ***# Rows by # Columns***. (Rows go across, columns up and down)

EXAMPLE: $B = \begin{bmatrix} 3 & 2 \\ 1 & 0 \\ -1 & -2 \end{bmatrix}$ ← *row*

↑ *Column*

Matrix B is a 3 x 2 matrix.

An element of a Matrix is the value in a particular position.

EXAMPLE: $B = \begin{bmatrix} 3 & 2 \\ 1 & 0 \\ -4 & -5 \end{bmatrix}$ $b_{row,column}$ $b_{1,2} = 2$ → 1st then ↓ 2nd

2 is the element in the 1st row and 2nd column

Use the matrices below to answer all questions.

$$A = \begin{bmatrix} 1 & 0 & -2 \\ 2 & 3 & 5 \\ 2 & -3 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 3 & 2 \\ 1 & 0 \\ -1 & -2 \end{bmatrix} \quad C = \begin{bmatrix} -3 & 0 & 2 \\ 1 & -1 & 0 \\ 0 & -4 & 3 \end{bmatrix} \quad D = \begin{bmatrix} -2 & -2 \\ 7 & 9 \\ 3 & 6 \end{bmatrix}$$

$$E = \begin{bmatrix} 2 & -8 & 13 & 5 \end{bmatrix} \quad F = \begin{bmatrix} 4 \\ 7 \end{bmatrix} \quad G = \begin{bmatrix} 0 & 2 & -4 \\ 3 & 5 & -5 \\ 1 & 1 & 6 \end{bmatrix} \quad H = \begin{bmatrix} -4 & 2 & 1 & 0 \\ -2 & -1 & 4 & 1 \end{bmatrix}$$

List the dimensions for the specified matrix

1. E 1 x 4
2. F 2 x 1
3. D 3 x 2
4. H 2 x 4
5. A 3 x 3
6. B 3 x 2

Identify the element in the specified locations, If possible.

5. Matrix D, $d_{2,1}$ 5. 7

6. Matrix A, $a_{2,3}$ 6. 5

7. Matrix H, $h_{4,1}$ 7. DNE ∅

8. Matrix E, $e_{1,3}$ 8. 13

If the Matrices are set equal to each other, ***each element must be the same.***

Solve for all variables

9. $\begin{bmatrix} 4 & x \\ y+3 & -8 \end{bmatrix} = \begin{bmatrix} 4 & 0 \\ 12 & z-8 \end{bmatrix}$

$x = 0$ $\quad y+3 = 12$, $y = 9$ $\quad -8 = z-8$, $0 = z$

10. $\begin{bmatrix} 2a+1 & 16 \\ 7-b & 1 \end{bmatrix} = \begin{bmatrix} 17 & 16 \\ -15 & c+4 \end{bmatrix}$

$2a+1 = 17$, $2a = 16$, $a = 8$ $\quad 7-b = -15$, $-b = -22$, $b = 22$ $\quad 1 = c+4$, $-3 = c$

ADDING, SUBTRACTING, AND SCALAR MULTIPLICATION

When Adding and Subtracting Matrices, the matrices ***must be the same exact size*!**

Adding- make sure you add ALL elements in the 2nd matrix.

Subtracting – make sure you subtract ALL elements in the 2nd matrix.

Add/Sub elements in the same positions the same sp

Scalar Multiplication – make sure you distribute the multiplier to ALL elements in the matrix.

EXAMPLES: $A = \begin{bmatrix} 1 & 0 & -2 \\ 2 & 3 & 5 \\ 2 & -3 & 0 \end{bmatrix}$ $C = \begin{bmatrix} -3 & 0 & 2 \\ 1 & -1 & 0 \\ 0 & -4 & 3 \end{bmatrix}$ Use the following matrices for these examples:

Work:

1. $A+C = \begin{bmatrix} 1+-3 & 0+0 & -2+2 \\ 2+1 & 3+-1 & 5+0 \\ 2+0 & -3+-4 & 0+3 \end{bmatrix}$ 2. $A-C = \begin{bmatrix} 1-(-3) & 0-0 & -2-2 \\ 2-1 & 3-(-1) & 5-0 \\ 2-0 & -3-(-4) & 0-3 \end{bmatrix}$ 3. $4A = \begin{bmatrix} 4(1) & 4(0) & 4(-2) \\ 4(2) & 4(3) & 4(5) \\ 4(2) & 4(-3) & 4(0) \end{bmatrix}$

Answer:

1. $A + C = \begin{bmatrix} -2 & 0 & 0 \\ 3 & 2 & 5 \\ 2 & -7 & 3 \end{bmatrix}$ 2. $A - C = \begin{bmatrix} 4 & 0 & -4 \\ 1 & 4 & 5 \\ 2 & 1 & -3 \end{bmatrix}$ 3. $4A = \begin{bmatrix} 4 & 0 & -8 \\ 8 & 12 & 20 \\ 8 & -12 & 0 \end{bmatrix}$

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MATRICES ON THE CALCULATOR

ADDITION, SUBTRACTION, AND SCALAR MULTIPLICATION:

You can enter and manipulate matrices with your graphing calculator (see directions below):

$$A=\begin{bmatrix}2 & -1\\ 7 & 4\end{bmatrix} \qquad B=\begin{bmatrix}6 & -3\\ 1 & 4\end{bmatrix} \qquad [A]+[B]=\begin{bmatrix}8 & -4\\ 8 & 8\end{bmatrix}$$

Entering the Matrix into the Calculator

- Go into the Matrix Menu
  - 2nd MATRX (the x^{-1} key)
    - ▶ (right arrow) over to **EDIT**
- Select a Matrix
  - ENTER for 1:[A] (This is Matrix A) OR
  - Use ▼ (down arrow) to select another Matrix in the list and push ENTER
- Input the Dimension (size) of the Matrix (***Rows x Columns***)
  - # of Rows ENTER
  - # of Columns ENTER
- Input the elements (values) of the Matrix
  - Type in each # so that the matrix in the calculator looks ***exactly*** like the matrix on the paper.
  - Use the arrow keys to move within the Matrix.
- When the Matrix is complete
  - 2nd QUIT

To Perform Operations on Matrices (Addition, Subtraction, Scalar Multiplication)

- Enter all the matrices you need to perform the operation(s).
- Go into the Matrix Menu
  - 2nd MATRX (the x^{-1} key)
    - Under **NAMES**, press ENTER for 1:[A] (This is Matrix A) OR
    - Use ▼ (down arrow) to select another Matrix in the list and push ENTER
- Name of the first Matrix will appear on the Home screen. Example: [A]
- Push the desired operation key: +, -, x Example: [A] +

- Go into the Matrix Menu
  - **2nd** **MATRX** (the x^{-1} key)
  - Use ▼ to select the other Matrix in the list and push **ENTER**
- Name of second Matrix will appear on the Home screen. Example: [A] + [B]
- Push **ENTER** and the result will be displayed on the Home screen.

Use your calculator to perform the appropriate operation on the given matrices

$$A=\begin{bmatrix}1 & 0 & 4\\ 6 & 3 & -3\\ 0 & -3 & 4\end{bmatrix}\quad B=\begin{bmatrix}2 & 7 & 0\\ -4 & 1 & 8\\ -2 & -4 & 1\end{bmatrix}\quad C=\begin{bmatrix}4 & 0\\ -9 & 2\\ 1 & 5\end{bmatrix}\quad D=\begin{bmatrix}0 & 1\\ -9 & -1\\ 4 & 3\end{bmatrix}\quad E=\begin{bmatrix}1 & 0 & 3\\ 4 & 0 & -7\\ 6 & 4 & 3\end{bmatrix}$$

1. B + A

1. $\begin{bmatrix}3 & 7 & 4\\ 2 & 4 & 5\\ -2 & -7 & 5\end{bmatrix}$

2. D – C

2. $\begin{bmatrix}-4 & 1\\ 0 & -3\\ 3 & -2\end{bmatrix}$

3. 3E

3. $\begin{bmatrix}3 & 0 & 9\\ 12 & 0 & -21\\ 18 & 12 & 9\end{bmatrix}$

4. B + A – C

4. not possible. C has different dimensions

5. 4A – 3E + B

5. $\begin{bmatrix}3 & 7 & 7\\ 8 & 13 & 17\\ -20 & -28 & 8\end{bmatrix}$

6. $A - B + E$

6. $\begin{bmatrix} 0 & -7 & 7 \\ 14 & 2 & -18 \\ 8 & 5 & 6 \end{bmatrix}$

7. $-3B - 6A$

7. $\begin{bmatrix} -12 & -21 & -24 \\ -24 & -21 & -6 \\ 6 & 30 & -27 \end{bmatrix}$

8. $8C - 3C$

8. $\begin{bmatrix} 20 & 0 \\ -45 & 10 \\ 5 & 25 \end{bmatrix}$

9. $E + 2A - 9B$

9. $\begin{bmatrix} -15 & -63 & 11 \\ 52 & -3 & -85 \\ 24 & 34 & 2 \end{bmatrix}$

10. $6C + 4D - 2C$

10. $\begin{bmatrix} 16 & 4 \\ -72 & 4 \\ 20 & 32 \end{bmatrix}$

$A = \begin{bmatrix} 2 & -5 \\ -1 & 7 \end{bmatrix}$ $B = \begin{bmatrix} 11 \\ -2 \\ 5 \end{bmatrix}$ $C = \begin{bmatrix} 2 & 0 & -4 \\ 8 & 3 & -4 \\ -9 & 2 & 5 \end{bmatrix}$ $D = \begin{bmatrix} 4 & -1 & 6 \end{bmatrix}$

$E = \begin{bmatrix} 6 & -8 \\ 0 & 3 \end{bmatrix}$ $F = \begin{bmatrix} 2 & 4 \\ -5 & 3 \\ 1 & 6 \end{bmatrix}$ $G = \begin{bmatrix} 10 & 1 & 0 \\ 2 & -4 & 5 \end{bmatrix}$ $H = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$I = \begin{bmatrix} 8 \\ -4 \\ 5 \end{bmatrix}$ $J = \begin{bmatrix} 1 & -4 & 7 \\ 3 & 6 & 9 \\ -2 & 0 & 2 \end{bmatrix}$ $K = \begin{bmatrix} 8 & 4 & -3 \\ 7 & 1 & 0 \end{bmatrix}$

List the dimensions for each specific matrix.

11. A 2×2
12. B 3×1
13. I 3×1
14. D 1×3
15. C 3×3
16. J 3×3
17. K 2×3
18. F 3×2

If possible, identify the element in the specific locations of the matrix.

19. Matrix C, $c_{2,3}$ −4
20. Matrix K, $k_{1,3}$ −3
21. Matrix A, $a_{2,2}$ 7
22. Matrix I, $i_{1,1}$ 8
23. Matrix D, $d_{1,3}$ 6
24. Matrix J, $j_{3,3}$ 2
25. Matrix B, $b_{3,1}$ 5
26. Matrix G, $g_{2,3}$ 5