Using Matrices to Represent Data

Name: ________________	Date: ____________	Score: ______ / 32

Quick Review

A **matrix** is a rectangular grid of numbers, written inside brackets, that lets you store an entire table of data in a single mathematical object. The **dimensions** of a matrix are written as *rows* $\times$ *columns* — always in that order. A 3×2 matrix has 3 rows and 2 columns; a 2×3 matrix has the rows and columns swapped, even though both hold 6 entries.

Each entry is named by its position: $a_{i,j}$ is the entry in *row* i, *column* j. So in $A = \begin{bmatrix} 5 & 8 & -2 \\ 1 & 0 & 6 \\ 3 & -4 & 7 \end{bmatrix}$, $a_{2,3} = 6$ (row 2, column 3). The big trap here is reversing the indices — $a_{3,2} = -4$, not 6. Whisper the order to yourself: row first, column second, every time.

A **row vector** is a $1 \times n$ matrix (one row); a **column vector** is $n \times 1$ (one column). A **square matrix** has equal rows and columns ($n \times n$). Only square matrices can have a determinant or an inverse, so squareness matters later. Two matrices are **equal** only when they have the same dimensions *and* every corresponding entry matches.

When you turn a data table into a matrix, decide what each row means and what each column means before writing anything. Below, the same Tuesday-coffee data sits in the table on the left and the matrix on the right — rows are days, columns are drink types.

Coffee Sales

Day	Lattes	Cappuccinos	Espressos
Mon	24	18	12
Tue	30	20	15

$$S = \begin{bmatrix} 24 & 18 & 12 \\ 30 & 20 & 15 \end{bmatrix}$$

PRACTICE

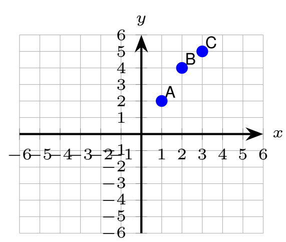
Read each table or matrix carefully. Find the requested entry, dimensions, or matrix form.

1. State the dimensions of $M = \begin{bmatrix} 2 & -1 & 0 \\ 4 & 7 & 3 \end{bmatrix}$. ________

Matrix M Layout

	Col 1	Col 2	Col 3
Row 1	2	-1	0
Row 2	4	7	3

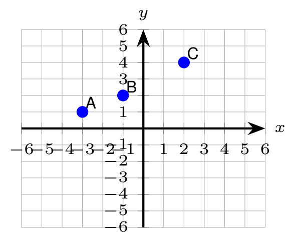
Coordinate check. Read each column as an ordered pair: top entry is x, bottom entry is y.



2. For $A = \begin{bmatrix} 5 & 8 & -2 \\ 1 & 0 & 6 \\ 3 & -4 & 7 \end{bmatrix}$, find $a_{2,3}$. ________

Entry Positions for A			
	Col 1	Col 2	Col 3
Row 1	5	8	-2
Row 2	1	0	6
Row 3	3	-4	7

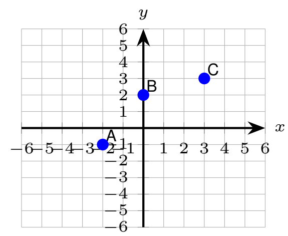
Coordinate check. Read each column as an ordered pair: top entry is x, bottom entry is y.



3. A 4×5 matrix has how many total entries? Think of the layout as 4 rows with 5 columns. ________

Counting Entries				
	Col 1	Col 2	⋯	Col 5
Row 1	☐	☐	⋯	☐
Row 2	☐	☐	⋯	☐
Row 3	☐	☐	⋯	☐
Row 4	☐	☐	⋯	☐

Coordinate check. Read each column as an ordered pair: top entry is x, bottom entry is y.

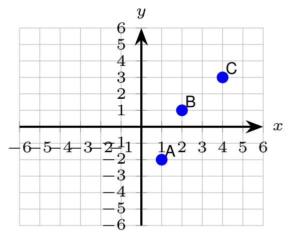


4. A school sold 40 adult and 25 student tickets on Day 1, then 32 adult and 48 student tickets on Day 2. Write the data as a 2×2 matrix with rows for days and columns for adult, student. ________

Ticket Sales

Day	Adult	Student
Day 1	40	25
Day 2	32	48

Coordinate check. Read each column as an ordered pair: top entry is x, bottom entry is y.

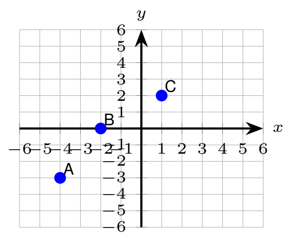


5. Three students recorded weekly study hours in Math, Science, and English: Aria $(8, 6, 5)$, Ben $(4, 7, 9)$, Cara $(10, 5, 6)$. Write the data as a 3×3 matrix with rows for students and columns for subjects. ________

Weekly Study Hours

Student	Math	Science	English
Aria	8	6	5
Ben	4	7	9
Cara	10	5	6

Coordinate check. Read each column as an ordered pair: top entry is x, bottom entry is y.



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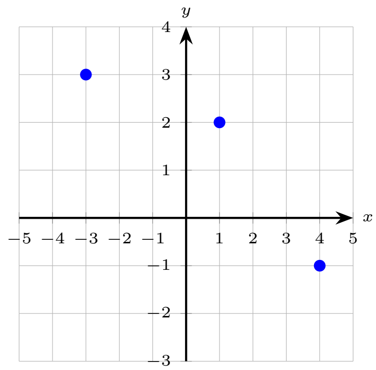
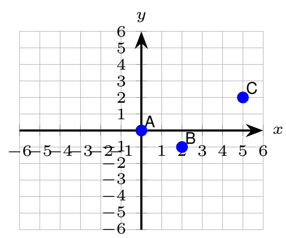
6. A data set of three points is stored as the columns of $M = \begin{bmatrix} 1 & 4 & -3 \\ 2 & -1 & 3 \end{bmatrix}$ (top row x, bottom row y). The points are plotted below. Which column gives the point in Quadrant II? ________



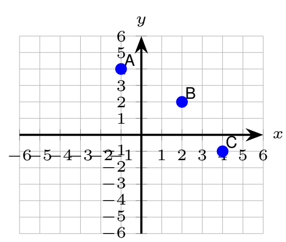
Coordinate check. Read each column as an ordered pair: top entry is x, bottom entry is y.



7. A store records sales using $T = \begin{bmatrix} 18 & 24 & 11 \\ 15 & 30 & 14 \end{bmatrix}$, where rows are locations (North, South) and columns are items (notebooks, pens, folders). What does $T_{2,3} = 14$ represent? ________

Store Sales			
Location	Notebooks	Pens	Folders
North	18	24	11
South	15	30	14

Coordinate check. Read each column as an ordered pair: top entry is x, bottom entry is y.



8. A theater records ticket sales: morning 32 child and 18 adult; afternoon 26 child and 41 adult; evening 15 child and 56 adult. Write the data as a 3×2 matrix P (rows: showtimes; columns: child, adult) and find $P_{3,2}$. ________

Theater Ticket Sales		
Showtime	Child	Adult
Morning	32	18
Afternoon	26	41
Evening	15	56

9. Two matrices are equal: $\begin{bmatrix} 2x-1 & y+3 \\ 4 & 7 \end{bmatrix} = \begin{bmatrix} 9 & -2 \\ 4 & 7 \end{bmatrix}$. Find x. ________

10. True or false: a column vector is a matrix with exactly one row. ________

11. State the dimensions of $\begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}$. ________

12. For $B = \begin{bmatrix} 3 & -2 & 5 \\ 0 & 7 & -1 \\ 4 & 8 & 2 \end{bmatrix}$, find $b_{3,1} + b_{1,3}$. ________

13. A delivery service tracks packages over three weekdays: Monday 42 in zone A and 35 in zone B; Tuesday 38 in zone A and 46 in zone B; Wednesday 51 in zone A and 29 in zone B. Write this as a 3×2 matrix D (rows are days; columns are zones). ________

Package Deliveries		
Day	Zone A	Zone B
Mon	42	35
Tue	38	46
Wed	51	29

14. For the matrix D from the previous problem, find $D_{2,1}$ and explain what it represents. ________

Matrix D Context		
Day	Zone A	Zone B
Mon	42	35
Tue	38	46
Wed	51	29

15. How many entries are in a 7×3 matrix? Could any of them be the same number? ________

16. True or false: matrices $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 2 & 0 \\ 3 & 4 & 0 \end{bmatrix}$ are equal because all the nonzero entries match. ________

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17. A weekly forecast records high temperatures (in °F) for three cities across two days: Boston Mon 48, Tue 52; Denver Mon 61, Tue 58; Miami Mon 79, Tue 82. Write the matrix with rows for cities and columns for days, and find the entry in row 3, column 2. ________

Forecast Highs (°F)		
City	Mon	Tue
Boston	48	52
Denver	61	58
Miami	79	82

18. True or false: the 1×3 matrix $\begin{bmatrix} 5 & -2 & 7 \end{bmatrix}$ is a row vector. ________

19. Build the matrix C where rows are Q1 and Q2 sales and columns are East, West, and Central regions. Q1: East 120, West 90, Central 75. Q2: East 150, West 110, Central 95. State the dimensions and find $C_{1,3}$. ________

Quarterly Sales			
Quarter	East	West	Central
Q1	120	90	75
Q2	150	110	95

20. For the matrices $A = \begin{bmatrix} a & 6 \\ 2 & b \end{bmatrix}$ and $B = \begin{bmatrix} 5 & 6 \\ 2 & 9 \end{bmatrix}$ to be equal, what must a and b be? ________

Word Problems

21. A small bookstore tracks weekday sales of three categories: fiction, nonfiction, and children's. Monday: 24 fiction, 18 nonfiction, 12 children's. Tuesday: 30 fiction, 20 nonfiction, 15 children's. Write the data as a matrix S with rows for days and columns for categories. How many children's books sold on Tuesday? ________

Bookstore Sales			
Day	Fiction	Nonfiction	Children's
Mon	24	18	12
Tue	30	20	15

22. An athletic department records points scored by two teams in two halves of a basketball game. Team A: 28 in the first half, 32 in the second. Team B: 25 in the first half, 30 in the second. Build the score matrix G with rows for teams and columns for halves, and find $G_{1,2} + G_{2,1}$. ________

Game Scores		
Team	1st Half	2nd Half
Team A	28	32
Team B	25	30

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23. A coach tracks shooting percentages (in %) for three players in two practice drills. Maya: drill 1 $\to 72\%$, drill 2 $\to 68\%$. Liam: drill 1 $\to 55\%$, drill 2 $\to 70\%$. Priya: drill 1 $\to 80\%$, drill 2 $\to 76\%$. Write the matrix P with rows for players, columns for drills, and find $P_{3,1} - P_{2,1}$ (Priya's drill 1 minus Liam's drill 1). ________

Shooting % by Drill		
Player	Drill 1	Drill 2
Maya	72	68
Liam	55	70
Priya	80	76

24. A pet shelter records adoptions and surrenders for three months. January: 42 adoptions, 18 surrenders. February: 36 adoptions, 22 surrenders. March: 51 adoptions, 14 surrenders. Build the 3×2 matrix S (rows: months; columns: adoptions, surrenders) and find the total adoptions across all three months. ________

Shelter Records		
Month	Adoptions	Surrenders
Jan	42	18
Feb	36	22
Mar	51	14

Additional Practice

25. State the dimensions of $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$. ________

26. Add $\begin{bmatrix} 1 & 4 \\ 2 & 0 \end{bmatrix} + \begin{bmatrix} 3 & -1 \\ 5 & 6 \end{bmatrix}$. ________

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

28. Find $\det \begin{bmatrix} 3 & 2 \\ 5 & 4 \end{bmatrix}$. ________

29. Find entry a_{21} in $\begin{bmatrix} 8 & 9 \\ -3 & 4 \end{bmatrix}$. ________

30. Can a 2×3 matrix multiply a 3×4 matrix? ________

31. Product size: $(2 \times 3)(3 \times 4)$. ________

32. Multiply $\begin{bmatrix} 2 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 5 \end{bmatrix}$. ________

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Answer Keys

1. $\boxed{2 \times 3}$
2. $\boxed{6}$
3. $\boxed{20}$
4. $\begin{bmatrix} 40 & 25 \\ 32 & 48 \end{bmatrix}$
5. $\begin{bmatrix} 8 & 6 & 5 \\ 4 & 7 & 9 \\ 10 & 5 & 6 \end{bmatrix}$
6. column 3: $(-3, 3)$
7. South sold 14 folders
8. $P_{3,2} = 56$
9. $x = 5$
10. false
11. 4×1
12. 9
13. $D = \begin{bmatrix} 42 & 35 \\ 38 & 46 \\ 51 & 29 \end{bmatrix}$
14. $D_{2,1} = 38$ (Tuesday, zone A)
15. 21 entries; yes, duplicates allowed
16. false
17. 82 (Miami, Tue)
18. true
19. $2 \times 3,\ C_{1,3} = 75$
20. $a = 5,\ b = 9$
21. $S_{2,3} = 15$
22. 57
23. 25
24. 129 adoptions

Additional Practice Answers

25. 2×3
26. $\begin{bmatrix} 4 & 3 \\ 7 & 6 \end{bmatrix}$
27. $\begin{bmatrix} 4 & -2 \\ 3 & 4 \end{bmatrix}$
28. 2
29. -3
30. yes
31. 2×4
32. 13

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. Count the rows (horizontal lines): 2. Count the columns (vertical lines): 3. Dimensions are rows $\times$ columns, so 2×3. (Reversing this to 3×2 is the most common slip — the row count comes first, always.)
2. The subscript $a_{i,j}$ means row i, column j. Walk to row 2: $(1, 0, 6)$. The third entry in that row is 6. Don't confuse this with $a_{3,2} = -4$ (row 3, column 2).
3. An $m \times n$ matrix has $m \cdot n$ entries. $4 \cdot 5 = 20$. Quick sanity check: that's 4 rows of 5 each, or 5 columns of 4 each — both routes give 20.
4. Each row is one day; each column is one ticket type. Row 1: $(40, 25)$. Row 2: $(32, 48)$. Stack them and you get the matrix above. (The order in the prompt — adult before student — fixes the column order.)
5. Each student's triple becomes one row of the matrix, in the order given. The columns line up Math, Science, English. (Transposing the matrix — swapping rows and columns — would change the meaning, so be careful.)
6. This is the heart of *using a matrix to represent data*: each column is one record, here an (x, y) point. Read the top entry as x and the bottom as y, so the columns are $(1, 2)$, $(4, -1)$, and $(-3, 3)$. Quadrant II is the upper-left region — negative x, positive y. Scan the plot for the dot left of the y-axis and above the x-axis: it sits at $(-3, 3)$, which is the third column.
7. Row 2 is South; column 3 is folders. $T_{2,3} = 14$ means South sold 14 folders. (Reading the entry without checking which row and column it sits in is a classic mistake — the position tells the story.)
8. Each showtime is a row; the columns are child, adult. Row 3 is evening; column 2 is adult. So $P_{3,2} = 56$, the evening adult-ticket count.
9. Equal matrices have equal corresponding entries at every spot. Match the top-left: $2x - 1 = 9$, so $x = 5$. (The other matched entries give $y = -5$, $4 = 4$, $7 = 7$ — consistent.)
10. A column vector has exactly one *column*, not one row. The matrix with exactly one row is a row vector. Easy to swap; remember the orientation by name — column vectors stand tall.
11. Four rows, one column. That makes it a 4×1 column vector. (If you flipped this to 1×4 you'd be describing a row vector — a different beast.)
12. Start with the key idea: $b_{3,1}$ is row 3, column 1: 4. $b_{1,3}$ is row 1, column 3: 5. Sum: $4 + 5 = 9$. (Saying r̈ow, columnäloud each time keeps the indices from swapping on you.) That gives a quick check on the answer.
13. Each day fills a row; each zone fills a column. The order in the prompt (zone A before zone B) fixes the column order. Don't transpose — a 2×3 matrix here would change the meaning.
14. Row 2 is Tuesday; column 1 is zone A. So $D_{2,1} = 38$, meaning 38 packages were delivered to zone A on Tuesday. Reading matrix entries always means putting the position back into context.
15. One steady path is: $7 \cdot 3 = 21$ entries. Matrices don't require all entries to be distinct — a matrix of all 0s has 21 entries that are all the same. Position, not value, is what makes each entry unique. That gives a quick check on the answer.
16. Equal matrices need the same dimensions *and* matching entries at every spot. A is 2×2 and B is 2×3 — different dimensions, so they cannot be equal regardless of what's inside.
17. Row 3 is Miami; column 2 is Tuesday. The entry is 82, which is Miami's high on Tuesday. (Cities are rows because that's the order the prompt gave.)
18. A row vector is any matrix with exactly one row. This has 1 row and 3 columns, so yes — 1×3 row vector. (The column version would be the 3×1 matrix with the same entries stacked vertically.)
19. Two rows (Q1, Q2) and three columns (East, West, Central) give a 2×3 matrix. $C_{1,3}$ is row 1, column 3: 75. That matches Q1 Central in the table — exactly what the position promised.
20. Equal matrices match position by position. Top-left: $a = 5$. Bottom-right: $b = 9$. The already-matching entries ($6 = 6$ and $2 = 2$) confirm both matrices are now the same.
21. Stack the rows in the order given: $S = \begin{bmatrix} 24 & 18 & 12 \\ 30 & 20 & 15 \end{bmatrix}$. The matrix is 2×3. Tuesday children's sales sit at row 2, column 3: $S_{2,3} = 15$. Reading the entry at the right position is the whole point of building the matrix — positions carry meaning.
22. Two rows, two columns: $G = \begin{bmatrix} 28 & 32 \\ 25 & 30 \end{bmatrix}$. $G_{1,2}$ is Team A's second half: 32. $G_{2,1}$ is Team B's first half: 25. Sum: $32 + 25 = 57$. (Saying r̈ow, columnöut loud keeps the indices from flipping.)
23. Build the matrix: $P = \begin{bmatrix} 72 & 68 \\ 55 & 70 \\ 80 & 76 \end{bmatrix}$, dimensions 3×2. $P_{3,1} = 80$ (Priya, drill 1). $P_{2,1} = 55$ (Liam, drill 1). Difference: $80 - 55 = 25$ percentage points. Matrix

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entries beat scrolling through prose because you go straight to the position.

24. The matrix is $S = \begin{bmatrix} 42 & 18 \\ 36 & 22 \\ 51 & 14 \end{bmatrix}$. Total adoptions is the sum of column 1: $42 + 36 + 51 = 129$. (Once your data lives in a matrix, asking for a column sum is the same as asking for a category total.)

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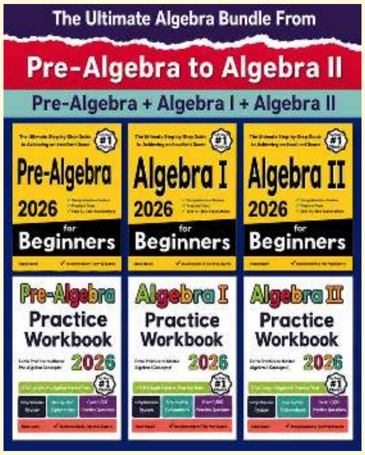

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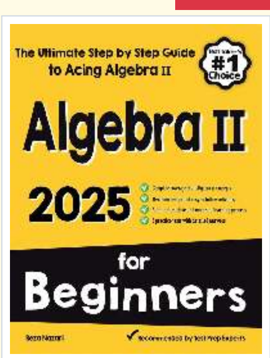

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