

6.1

Representing Data in Matrices

TEKS

AR.5 The student applies mathematical processes to represent, simplify, and perform operations on matrices and to solve systems of equations using matrices.

MATHEMATICAL PROCESS SPOTLIGHT

AR.1E Create and use representations to organize, record, and communicate mathematical ideas.

ELPS

4F Use visual and contextual support and support from peers and teachers to read grade-appropriate content area text, enhance and confirm understanding, and develop vocabulary, grasp of language structures, and background knowledge needed to comprehend increasingly challenging language.

VOCABULARY

matrix, array

MATERIALS

- Sticky notes (25 per student pair) or rectangular pieces of scrap paper (25 per student pair)



FOCUSING QUESTION What is a matrix, and how do I use it to represent and organize a set of data?

LEARNING OUTCOMES

- I can use a matrix to represent and organize a data set.
- I can apply mathematics to solve problems arising in everyday life, society, and the workplace.



ENGAGE

A trilogy is a set of three. Popular movie trilogies have generated hundreds of millions of dollars in box office sales. The list below shows the worldwide box office revenue for certain movie trilogies.

- The Matrix (1999), \$463,420,706; The Matrix Reloaded (Part 2, 2003), \$738,576,929; The Matrix Revolutions (Part 3, 2003), \$427,289,109
- Star Wars, Episode IV (1977), \$786,535,665; Star Wars, Episode V (1980), \$534,058,751; Star Wars, Episode VI (1983), \$572,625,409
- Jurassic Park (1993), \$1,038,812,584; The Lost World: Jurassic Park (Part 2, 1997), \$618,626,844; Jurassic Park III (2001), \$365,900,000

Create an array where each row represents a trilogy and each column represents the worldwide box office revenue for Part 1, Part 2, and Part 3 of that movie.

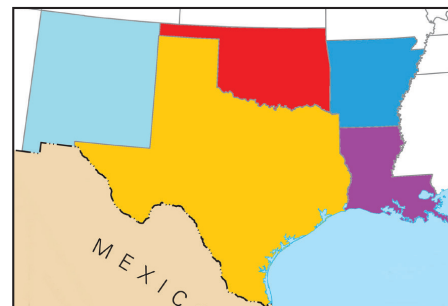
See margin.



EXPLORE

The list below contains the populations in 2014, according to the U.S. Census Bureau, of the five largest cities in Texas and each adjacent state.

- Arkansas: Little Rock (197,706), Fort Smith (87,351), Fayetteville (80,621), Springdale (76,565), Jonesboro (72,210)
- Louisiana: New Orleans (384,320), Baton Rouge (228,895), Shreveport (198,242), Lafayette (126,066), Lake Charles (74,889)



ENGAGE ANSWER:

	Part 1	Part 2	Part 3
<i>The Matrix</i>	\$463,420,706	\$738,576,929	\$427,289,109
<i>Star Wars</i>	\$786,535,665	\$534,058,751	\$572,625,409
<i>Jurassic Park</i>	\$1,038,812,584	\$618,626,844	\$365,900,000

1. Possible answer (rows and columns are labeled for convenience, but will not be labeled in students' arrays):

	1st	2nd	3rd	4th	5th
Arkansas	197,706	87,351	80,621	76,565	72,210
Louisiana	384,320	228,895	198,242	126,066	74,889
New Mexico	557,169	101,408	93,820	70,297	48,608
Oklahoma	620,602	399,682	118,040	104,726	97,017
Texas	2,239,558	1,436,697	1,281,047	912,791	812,238

- New Mexico: Albuquerque (557,169), Las Cruces (101,408), Rio Rancho (93,820), Santa Fe (70,297), Roswell (48,608)
- Oklahoma: Oklahoma City (620,602), Tulsa (399,682), Norman (118,040), Broken Arrow (104,726), Lawton (97,017)
- Texas: Houston (2,239,558), San Antonio (1,436,697), Dallas (1,281,047), Austin (912,791), Fort Worth (812,238)

1. Work with a partner. Write the population of each city on a separate sticky note or piece of paper. Arrange the sticky notes in an array so that each row represents one state and each column represents the population of the largest, 2nd largest, 3rd largest, 4th largest, and 5th largest cities in that state. To better organize your arrangement, you may wish to place the rows so that the states are listed alphabetically.
See margin.
2. Record the array on a piece of paper. Place large brackets around the left and right sides of your array.
See margin.

A **matrix** is a rectangular array with data organized into rows and columns. Brackets are used to indicate the boundaries of a matrix. Entries in a matrix are identified by the row and column in which they appear.

3. In your matrix, identify the entry in Row 2, Column 3 (notated: $a_{2,3}$). In this notation, a represents an entry in matrix A .
Answers may vary. Based on matrix from previous question: 198,242.
4. Use matrix notation to identify the entry that represents the population of Austin, Texas, and the entry that represents Shreveport, Louisiana.
See margin.
5. The list below shows the number of regular season games won by 6 university football teams for 4 recent years. Create a matrix for the data set shown by placing the universities in each row and the years in each column.
 - University of Texas: 9 (2012), 8 (2013), 6 (2014), 5 (2015)
 - Texas A&M University: 11 (2012), 9 (2013), 8 (2014), 8 (2015)
 - University of Michigan: 8 (2012), 7 (2013), 5 (2014), 9 (2015)
 - University of Arkansas: 4 (2012), 3 (2013), 7 (2014), 7 (2015)
 - University of Louisville: 11 (2012), 12 (2013), 9 (2014), 7 (2015)
 - Stanford University: 12 (2012), 11 (2013), 8 (2014), 11 (2015)**See margin.**
6. In which row and column is the entry 3?
Row 4, column 2, or $a_{4,2}$
7. What is the entry for $a_{6,3}$?
8
8. How does the shape of the football matrix compare to the shape of the largest cities matrix?
See margin.

1. See bottom of page 642.
2. See below.

INTEGRATING TECHNOLOGY

Graphing calculators or other graphing technologies can be used to create and store matrices of data. Spreadsheets also function like matrices with cells identified by their row column.

SUPPORTING ENGLISH LANGUAGE LEARNERS

Students can use support from their peers and teachers to develop vocabulary needed to comprehend increasingly challenging language (ELPS 4F). To do so, arrange students in pairs so that they can communicate with each other and ask the teacher questions as needed. Focus on new vocabulary. In this lesson, students will use the word matrix in a mathematical sense. Students will also use vocabulary words row and column in a new context. As the language becomes increasingly challenging, make sure that students have support from their peers and from the teacher.

4. **Answers may vary. Based on matrix from previous question:**
Austin, Texas: $a_{5,4}$
Shreveport, Louisiana: $a_{2,3}$

$$2. \begin{bmatrix} 197,706 & 87,351 & 80,621 & 76,565 & 72,210 \\ 384,320 & 228,895 & 198,242 & 126,066 & 74,889 \\ 557,169 & 101,408 & 93,820 & 70,297 & 48,608 \\ 620,602 & 399,682 & 118,040 & 104,726 & 97,017 \\ 2,239,558 & 1,436,697 & 1,281,047 & 912,791 & 812,238 \end{bmatrix}$$

$$5. \begin{bmatrix} 9 & 8 & 6 & 5 \\ 11 & 9 & 8 & 8 \\ 8 & 7 & 5 & 9 \\ 4 & 3 & 7 & 7 \\ 11 & 12 & 9 & 7 \\ 12 & 11 & 8 & 11 \end{bmatrix}$$

8. **Answers may vary. Possible answers:**

The football matrix is rectangular and the largest cities matrix is square. The largest cities matrix has fewer rows but more columns than the football matrix. The largest cities matrix has the same number of rows and columns but the football matrix does not.

REFLECT ANSWER:

Identify categories of data. Place data elements from the same category in the same row. Arrange the data elements so that the entries in each column correspond in a second category.



REFLECT

- How does a matrix help you to organize data?
A matrix organizes data by using rows and columns. Data elements that go together in one category are either in the same row or column.
- How can you represent a data set in a matrix?
See margin.



EXPLAIN

A matrix is a way to record, organize, and represent data. Like an array, a matrix uses rows and columns to organize the data. Each matrix entry corresponds with one row and one column and can be identified by its row and column location, much like a coordinate system.



For example, the table shows the number of cheeseburgers and chicken nugget baskets sold in the school cafeteria for each of five days during one week.

The same data set could also be represented in a matrix. Each row represents a day of the week. Each column represents one food item: the first column represents the number of cheeseburgers sold and the second column represents the number of chicken nugget baskets sold.

The word **matrix** is singular, meaning only one matrix. The word **matrices** is plural and used when describing more than one matrix.

DAY	NUMBER OF CHEESE-BURGERS SOLD	NUMBER OF CHICKEN NUGGET BASKETS SOLD
MONDAY	97	86
TUESDAY	103	105
WEDNESDAY	110	97
THURSDAY	85	113
FRIDAY	120	98

Cheeseburgers

Chicken Nuggets

$$\begin{bmatrix} 97 & 86 \\ 103 & 105 \\ 110 & 97 \\ 85 & 113 \\ 120 & 98 \end{bmatrix}$$

Day of the Week

A matrix can have a name, such as Matrix A. The dimensions of a matrix are given by the number of rows and number of columns, respectively. If matrix A is the school cafeteria matrix, then matrix A is a 5×2 matrix since it has **5 rows** and **2 columns**.

Watch Explain and You Try It Videos



or [click here](#)

The rows and columns in a matrix are used to identify the data entries. . The row and column are used like coordinates to identify a particular entry.

$$\begin{bmatrix} 97 & 86 \\ 103 & 105 \\ 110 & 97 \\ 85 & 113 \\ 120 & 98 \end{bmatrix} \longleftrightarrow \begin{bmatrix} a_{1,1} & a_{1,2} \\ a_{2,1} & a_{2,2} \\ a_{3,1} & a_{3,2} \\ a_{4,1} & a_{4,2} \\ a_{5,1} & a_{5,2} \end{bmatrix}$$

The letter a is used to represent an entry in matrix A . Subscripts are used to indicate the row and column, in order, of the location of the entry. The entry in matrix A for Tuesday's number of cheeseburgers sold, 103, is $a_{2,1}$ since it is located in **Row 2** and **Column 1**.

Matrices are especially useful for performing calculations on large data sets. Computer programs and numerical models use matrices extensively because the procedures for computing with matrices are very routine. In the rest of this chapter, you will investigate how to add, subtract, and multiply data in matrices.

REPRESENTING DATA IN A MATRIX

A matrix is a rectangular array of numbers that are arranged in rows and columns.

- The dimensions of a matrix are the number of rows by the number of columns. A matrix with 6 rows and 4 columns is a 6×4 matrix.
- Each row is one category and each column is a category.
- Data elements, or *entries*, in one row must all share the same category.
- Entries in one column must all share the same category.
- Entries are identified by their row and column numbers. The entry of matrix A that is found in row 3 and column 1 is identified by $a_{3,1}$.



INSTRUCTIONAL HINTS

Students often mix up rows and columns when looking at matrices. Have images of buildings with columns to remind students that columns are up and down, not side to side.

A mnemonic device like “matrices are *Really Cool*” might assist students in remembering that rows are written first and columns second.



EXAMPLE 1

Organize the data about the box office earnings of the Star Wars movies into a matrix. The earnings are rounded to nearest tenth of a million dollars. Explain your categories and organizational layout. Identify the dimensions of the matrix you have constructed.

RELEASE DATE	MOVIE	DOMESTIC OPENING WEEKEND	DOMESTIC BOX OFFICE	WORLDWIDE BOX OFFICE
MAY 25, 1977	STAR WARS EP. IV: A NEW HOPE	1.5	460.9	786.5
MAY 21, 1980	STAR WARS EP. V: THE EMPIRE STRIKES BACK	4.9	290.2	534.1
MAY 25, 1983	STAR WARS EP. VI: RETURN OF THE JEDI	23.0	309.1	572.6
MAY 19, 1999	STAR WARS EP. I: THE PHANTOM MENACE	64.8	474.5	1,027.0
MAY 16, 2002	STAR WARS EP. II: ATTACK OF THE CLONES	80.0	302.2	648.2
MAY 19, 2005	STAR WARS EP. III: REVENGE OF THE SITH	108.4	380.3	849.0
DEC 18, 2015	STAR WARS EP. VII: THE FORCE AWAKENS	248.0	740.3	1,510.8

Source: Nash Information Services, LLC

STEP 1 Decide what category you could use to organize the data in rows.

You could place the movies as categories in the rows, as they are in order of their release date in the table or arranged numerically by episode.

STEP 2 Decide what category you could use to organize the data in columns.

You could place the three categories of earnings: domestic opening weekend, domestic box office, and worldwide box office, across the columns.

STEP 3 Enter the amounts in the matrix according to your layout decisions. Units, including dollar signs, are not included in matrices. Add brackets. The titles of the rows and columns are not part of the matrix. Shown is one possible matrix.

ADDITIONAL EXAMPLE

Lin sells jewelry in her online shop. The chart below shows the profit from daily sales of various types of jewelry over the course of a week. Organize the data from Lin's sales into a matrix. Explain how you chose to organize your matrix, and identify the dimensions of the matrix you constructed.

DAY OF WEEK	RINGS	BRACELETS	EARRINGS	NECKLACES
SUNDAY	\$45	\$15	\$40	\$86
MONDAY	\$40	\$34	\$94	\$90
TUESDAY	\$55	\$0	\$13	\$111
WEDNESDAY	\$5	\$45	\$60	\$8
THURSDAY	\$12	\$67	\$16	\$19
FRIDAY	\$75	\$69	\$71	\$74
SATURDAY	\$80	\$90	\$140	\$183

45	15	40	68
40	34	94	90
55	0	13	111
5	45	60	8
12	67	16	19
75	69	71	74
80	90	140	183

Answers may vary. One possible answer might be using the days of the week as row categories and the jewelry types as the column categories. This is a 7 X 4 matrix.

INSTRUCTIONAL HINT

Watch as students write their matrices to build good foundational notation skills. For instance, students should not write symbols, such as dollar signs, in their matrices. In the Additional Example on page 646, there is a zero in the data. Some students might not write the zero.

	Domestic Opening Box Office	Domestic Box Office	Worldwide Box Office
Star Wars IV	1.5	460.9	786.5
Star Wars V	4.9	290.2	534.1
Star Wars VI	23.0	309.1	572.6
Star Wars I	64.8	474.5	1,027.0
Star Wars II	80.0	302.2	648.2
Star Wars III	108.4	380.3	849.0
Star Wars VII	248.0	740.3	1,510.8

STEP 4 Determine the dimensions of your matrix.

If your columns are the categories of earnings and your rows are categorized by the movies, the matrix would be 7 rows by 3 columns or 7×3 as in the example in Step 2. Instead, if your columns are categorized by the movies and the rows are the earnings categories, the matrix would be 3 rows by 7 columns or 3×7 .



YOU TRY IT! #1

Choose some of the data from the chart and organize the data you've chosen into a matrix. Explain your choices and how you organized the categories, including any rounding. Identify the dimensions of the matrix you have constructed.

BOX OFFICE COMPARISON FOR ALL-TIME TOP-GROSSING FILMS

MOVIE	PRODUCTION BUDGET	DOMESTIC OPENING WEEKEND	DOMESTIC BOX OFFICE	WORLDWIDE BOX OFFICE
TITANIC	\$200,000,000	\$28,638,131	\$658,672,302	\$2,207,615,668
AVATAR	\$425,000,000	\$77,025,481	\$760,507,625	\$2,783,918,982
THE AVENGERS	\$225,000,000	\$207,438,708	\$623,279,547	\$1,519,479,547
JURASSIC WORLD	\$215,000,000	\$208,806,270	\$652,198,010	\$1,670,328,025
STAR WARS EP. VII: THE FORCE AWAKENS	\$200,000,000	\$247,966,675	\$740,265,583	\$1,510,765,583

Source: Nash Information Services, LLC

See margin.

YOU TRY IT! #1 ANSWER:

Answers will vary. A possible choice might be using the Production Budget and Worldwide Box Office earnings, rounded to the nearest million, for the column categories, and three films, Titanic, Avatar, and Star Wars Ep. VII: The Force Awakens, for the row categories. This is a 3×2 matrix.

200	2,208
425	2,784
200	1,511



EXAMPLE 2

Given Matrix A_1 showing the American Football Conference South Division standings as of week 17 in the 2015 season, identify what the data entries in $a_{4,2}$, $a_{1,3}$, and $a_{3,1}$ represent.



Image source: openclipart.org

	Wins	Losses/Ties	Percent Won	
$A_1 =$	9	7	56.3	Houston Texans
	8	8	50.0	Indianapolis Colts
	5	11	31.3	Jacksonville Jaguars
	3	13	18.8	Tennessee Titans

Source: NFL.com

STEP 1 Recall that $a_{4,2}$ means the entry in the 4th row and 2nd column.

The data in that location are the losses and ties for the Tennessee Titans (13 losses/ties).

STEP 2 Determine the entry in $a_{1,3}$.

The data in the 1st row and 3rd column shows the percent of games won by the Houston Texans (56.3%: 9 wins compared to 16 games in all).

STEP 3 Determine the entry in $a_{3,1}$.

This is not the same as the entry in $a_{1,3}$. The data in the 3rd row and 1st column are the wins for the Jacksonville Jaguars (5 wins).

YOU TRY IT! #2 ANSWER:

The data entry in $a_{2,3}$ is the percent won for the New York Jets (62.5% 10 wins compared to 16 games). For $a_{4,1}$, the entry is the number of wins for the Miami Dolphins (6 wins), and for $a_{3,2}$, the entry is the number of losses and ties for the Buffalo Bills (8 losses/ties).



YOU TRY IT! #2

Given Matrix A_2 showing the American Football Conference East Team standings as of week 17 in the 2015 season, identify what the data entries in $a_{2,3}$, $a_{4,1}$, and $a_{3,2}$ represent.

	Wins	Losses/Ties	Percent Won	
$A_2 =$	12	4	75.0	New England Patriots
	10	6	62.5	New York Jets
	8	8	50.0	Buffalo Bills
	6	10	37.5	Miami Dolphins

Source: NFL.com

See margin.

ADDITIONAL EXAMPLE

Given Matrix A_3 , showing the local high schools' girls soccer team standings as of the end of the 2015 season, identify what the data entries in $a_{2,1}$, $a_{1,2}$, and $a_{4,3}$ represent.

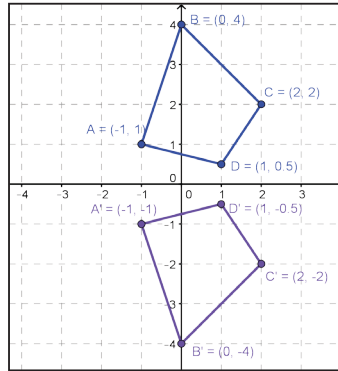
	Wins	Losses/ Ties	Percent Won	
$A_3 =$	13	3	81.25	West High School
	10	6	62.50	East High School
	9	7	56.25	North High School
	5	11	31.25	South High School

The data entry in $a_{2,1}$ is the number of wins for East High School (10 wins). For $a_{1,2}$, the entry is the number of losses and ties for West High School (3 losses/ties), and for $a_{4,3}$, the entry is the percent won for South High School (31.25% 5 wins compared to 16 games).



EXAMPLE 3

One use of matrices is to describe transformations of geometric figures. On the graph, quadrilateral $ABCD$ has been reflected over the x -axis. The coordinates of each figure are listed. Create two matrices, one for each list, and compare the data sets.



$$\begin{aligned} A &= (-1, 1) & A' &= (-1, -1) \\ B &= (0, 4) & B' &= (0, -4) \\ C &= (2, 2) & C' &= (2, -2) \\ D &= (1, 0.5) & D' &= (1, -0.5) \end{aligned}$$

STEP 1 Make a matrix, M_1 , for quadrilateral $ABCD$.

$$M_1 = \begin{matrix} & A & B & C & D \\ x & \begin{bmatrix} -1 & 0 & 2 & 1 \end{bmatrix} \\ y & \begin{bmatrix} 1 & 4 & 2 & 0.5 \end{bmatrix} \end{matrix}$$

STEP 2 Make a matrix, M_2 , for quadrilateral $A'B'C'D'$.

$$M_2 = \begin{matrix} & A' & B' & C' & D' \\ x & \begin{bmatrix} -1 & 0 & 2 & 1 \end{bmatrix} \\ y & \begin{bmatrix} -1 & -4 & -2 & -0.5 \end{bmatrix} \end{matrix}$$

STEP 3 Describe the layout of the matrices and compare the data in them.

The first row contains the x -coordinates and the second row contains the y -coordinates of each of the vertices. The columns show the names of the vertices for each figure. Both are 2×4 matrices. The data sets are the same except the y -coordinates are opposites.



YOU TRY IT! #3

Use the tables for the sales after Thanksgiving Day at the Que Cute Boutique to construct a matrix for each. Make a 3×2 matrix for the sales for weeks 1 through 3 and a 2×3 matrix for the sales for weeks 4 through 6. Use the data to compare shirt and pants sales and the trend overall for sales.

WEEK	SHIRTS	PANTS
1	\$725	\$695
2	\$540	\$485
3	\$565	\$505

WEEK	SHIRTS	PANTS
4	\$805	\$725
5	\$875	\$810
6	\$900	\$995

See margin.

YOU TRY IT! #3 ANSWER:

M_1 is a 3×2 matrix with the weeks in the rows and the sales of shirts and pants in the columns. M_2 has the rows and columns reversed. Shirt sales always appear to be greater than pants sales except for the sixth week. The sales overall drop from week 1 to 2 and then increase steadily to week 6.

$$M_1 = \begin{bmatrix} 725 & 695 \\ 540 & 485 \\ 565 & 505 \end{bmatrix}$$

$$M_2 = \begin{bmatrix} 805 & 875 & 900 \\ 725 & 810 & 995 \end{bmatrix}$$

ADDITIONAL EXAMPLE

Use the tables for Mark's bills for the month of February to construct a matrix for each. Use the data to compare grocery and utilities payments and the trend overall for bills.

WEEK	GROCERIES	UTILITIES
1	\$122	\$114
2	\$100	\$97

WEEK	GROCERIES	UTILITIES
3	\$75	\$53
4	\$52	\$0

M_1 and M_2 are both 2×2 matrices with the groceries and utilities bills in the columns and the weeks in the rows. M_1 represents the first two weeks of February while M_2 represents the last two weeks. Mark's bills overall seem to be higher in the first half of the month and drop to about a quarter of the first week's cost by the end of the month.

$$M_1 = \begin{bmatrix} 122 & 114 \\ 100 & 97 \end{bmatrix} \quad M_2 = \begin{bmatrix} 75 & 53 \\ 52 & 0 \end{bmatrix}$$



PRACTICE/HOMEWORK

Use the matrix shown to answer questions 1 – 4.

$$\text{Matrix } C = \begin{bmatrix} 88.5 & 74 & 105 & 92.5 \\ 110 & 91.3 & 89 & 133 \\ 181.6 & 112.1 & 76 & 142.6 \end{bmatrix}$$

- What are the dimensions of Matrix C ?
Matrix C has 3 rows and 4 columns, so it is a 3×4 matrix.
- What is the value of entry $c_{1,2}$?
74
- What is the value of entry $c_{2,1}$?
110
- What is the value of entry $c_{3,2}$?
112.1

Use the data below to answer questions 5 – 7.



HEALTH

PERCENT OF THE POPULATION OVER THE AGE OF 60

COUNTRY	2010	2011	2012
AUSTRALIA	18.9	19.2	19.5
BELIZE	5.6	5.7	5.7
CZECH REPUBLIC	22.4	22.8	23.2
KENYA	4.1	4.2	4.3

Source: World Health Organization (www.who.int)

- Organize the population data into a matrix.
See margin.
- What are the dimensions of your matrix?
Answers will vary. Depending on how the data was organized, it may be a 4×3 matrix or a 3×4 matrix.
- What percent of the population of Belize was over the age of 60 in the year 2011?
5.7% of the population was over the age of 60 in the year 2011.

5. *Answers will vary. Two possible matrix choices:*

$$\begin{matrix} & 2010 & 2011 & 2012 \\ \text{Australia} & 18.9 & 19.2 & 19.5 \\ \text{Belize} & 5.6 & 5.7 & 5.7 \\ \text{Czech Republic} & 22.4 & 22.8 & 23.2 \\ \text{Kenya} & 4.1 & 4.2 & 4.3 \end{matrix} \left[\right.$$

$$\begin{matrix} \text{Australia} & \text{Belize} & \text{Czech Republic} & \text{Kenya} \\ 2010 & 18.9 & 5.6 & 22.4 & 4.1 \\ 2011 & 19.2 & 5.7 & 22.8 & 4.2 \\ 2012 & 19.5 & 5.7 & 23.2 & 4.3 \end{matrix} \left[\right.$$

Matrix A shows information about six teams in the Western Conference of the NBA during the month of November, 2015. Use the matrix data to answer questions 8 – 10.



SPORTS

	Wins	Losses/Ties	Percent Won	
Matrix A:	9	7	56.3	Dallas Mavericks
	2	12	14.3	LA Lakers
	9	7	56.3	Oklahoma City Thunder
	7	9	43.8	Houston Rockets
	13	3	81.3	San Antonio Spurs
	6	7	46.2	Utah Jazz

Source: NBA.com

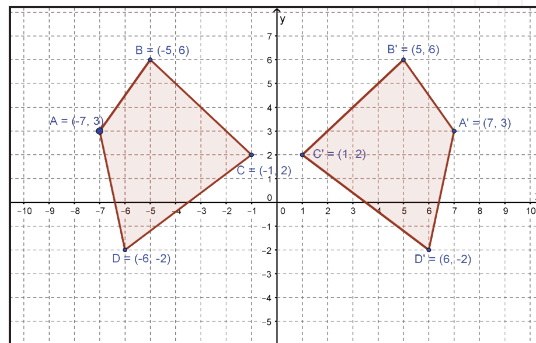
- Describe the data entry in $a_{5,1}$.
The San Antonio Spurs had 13 wins in November, 2015.
- Describe the data entry in $a_{1,3}$.
The Dallas Mavericks won 56.3% of their November, 2015 games.
- Describe the data entry in $a_{3,2}$.
Oklahoma City Thunder had 7 losses in November, 2015.

On the graph, quadrilateral ABCD has been reflected over the y-axis. The coordinates of each figure are listed. Use the information to answer questions 11 – 13.



GEOMETRY

$$\begin{array}{ll} A = (-7, 3) & A' = (7, 3) \\ B = (-5, 6) & B' = (5, 6) \\ C = (-1, 2) & C' = (1, 2) \\ D = (-6, -2) & D' = (6, -2) \end{array}$$



- Create a matrix, M_1 , for quadrilateral ABCD.
See margin.
- Create a matrix, M_2 , for quadrilateral $A'B'C'D'$.
See margin.
- Compare the data from matrices M_1 and M_2 .
The y-values for each point are the same for M_1 and M_2 . The x-values are opposites.

11.

Matrix M_1 :

	A	B	C	D
x	-7	-5	-1	-6
y	3	6	2	-2

12.

Matrix M_2 :

	A'	B'	C'	D'
x	7	5	1	6
y	3	6	2	-2

The table below shows the monthly sales of different drinks at a concession stand. Use this data to answer questions 14 and 15.



BUSINESS

DRINK	SMALL	MEDIUM	LARGE	EXTRA LARGE
LEMONADE	321	459	324	156
TEA	244	324	143	20
SPORTS DRINK	154	215	63	89
WATER	213	234	368	342
COLA	352	367	547	108

14. Create a 5×4 matrix, M_1 , to represent the concession stand data.
See margin.
15. Create a 4×5 matrix, M_2 , to represent the same concession stand data.
See margin.

Matrix A shows information collected from a customer survey. A customer rated different brands of socks on a scale of 1 to 5 (with 1 being the lowest score). Use this matrix to answer questions 16 – 18.



BUSINESS

Matrix A:		Comfort	Cost	Appearance
	Brand A	5	3	4
	Brand B	4	4	3
	Brand C	4	2	1
	Brand D	4	5	5

16. What are the dimensions of the matrix?
Matrix A is a 4×3 matrix.
17. Describe the data entry in $a_{3,1}$.
Brand C scored a 4 out of a possible 5 in sock comfort.
18. Which brand received the best overall ratings?
Brand D, because it rated 14 out of a possible 15 points, which is higher than the other brands' overall scores.

14.		<i>Small</i>	<i>Medium</i>	<i>Large</i>	<i>Extra Large</i>	15.	<i>Lemonade</i>	<i>Tea</i>	<i>Sports Drink</i>	<i>Water</i>	<i>Cola</i>	
	<i>Lemonade</i>	321	459	324	156		<i>Small</i>	321	244	154	213	352
	<i>Tea</i>	244	324	143	20		<i>Medium</i>	459	324	215	234	367
	<i>Sports Drink</i>	154	215	63	89		<i>Large</i>	324	143	63	368	547
	<i>Water</i>	213	234	368	342		<i>Extra Large</i>	156	20	89	342	108
	<i>Cola</i>	352	367	547	108							

Matrix B shows information about the maximum outdoor temperature on certain dates in four Texas cities. Use this matrix to answer questions 19 – 20.



SCIENCE

Matrix B :

	January 1, 2015	July 4, 2015	October 1, 2015
Houston	47° F	92° F	76° F
Dallas	37° F	95°	66° F
El Paso	46° F	96° F	68° F
Lubbock	26° F	91° F	70° F

Source: Weather Underground (wunderground.com)

19. Describe the data entry in $b_{2,1}$.
Dallas had a maximum temperature of 37° F on January 1, 2015.
20. Which city seems to generally be cooler than the others?
Lubbock, Texas