

- **Pathway:** Horticulture
- **Lesson:** HC B3–14: Pricing Floral Design Work
- **Common Core State Standards for Mathematics:** 9-12.N-VM.6, 7, 8

Domain: Vector and Matrix Quantities N-VM

Cluster: Perform operations on matrices and use matrices in applications.

Standard: 6. Use matrices to represent and manipulate data.

Standard: 7. Multiply matrices by scalars to produce new matrices.

Standard: 8. Add, subtract, and multiply matrices of appropriate dimensions.

- **Student Objective:** Students will organize floral design cost data into matrices and perform matrix operations (scalar multiplication, addition, and subtraction) to determine unit cost of goods and calculate ratio markup.

BACKGROUND KNOWLEDGE for Teachers and Students

➤ **Math Concepts:**

A *matrix* is a rectangular arrangement of numbers used to organize data. An example of a matrix is below.

$$\begin{bmatrix} 1.75 & 2.90 & 1.25 \\ 2.15 & 0.95 & 3.00 \end{bmatrix}$$

It is helpful to label the rows and columns of a matrix to indicate what the numbers represent. The matrix above has two rows and three columns, so its dimensions would be written as 2×3 . A *row matrix* is a matrix that has only one row, and a *column matrix* is a matrix that has only one column.

Scalar multiplication refers to multiplying a matrix by a number. For example, if each value in our matrix above were to be tripled, we would multiply the matrix by 3. The result would be a matrix of the same dimensions in which each value has been multiplied by 3.

$$3 \begin{bmatrix} 1.75 & 2.90 & 1.25 \\ 2.15 & 0.95 & 3.00 \end{bmatrix} = \begin{bmatrix} 5.25 & 8.70 & 3.75 \\ 6.45 & 2.85 & 9.00 \end{bmatrix}$$

In order to *add* or *subtract* two matrices, they must have the same dimensions. The corresponding values in each matrix are then added or subtracted.

$$\begin{bmatrix} 5 & -6 \\ -1 & 2 \end{bmatrix} + \begin{bmatrix} 3 & 0 \\ -8 & 8 \end{bmatrix} = \begin{bmatrix} 5 + 3 & -6 + 0 \\ -1 + -8 & 2 + 8 \end{bmatrix} = \begin{bmatrix} 8 & -6 \\ -9 & 10 \end{bmatrix}$$

➤ Agriculture Concepts:

In the floral industry, florists purchase flowers and other plant materials from wholesalers, who buy directly from growers. Wholesalers sell products only in bulk. This generally means the cost is lower per item. Florists then create arrangements and other floral design products using the wholesale items. To make a profit, a florist uses a markup strategy that accounts for the cost of hardgood items (such as vases and ribbon), operation costs, and labor, in addition to wholesale cost, to arrive at a final price for the consumer product.

Guided Practice Exercises: ANSWER KEY

1. A 3×6 matrix has 3 rows and 6 columns. For this matrix, each column represents a different type of flower, and each row represents what is in each arrangement. The order of the columns is not important, but labels help to clarify what the numbers in the matrix represent.

| | Q | B | R | C | H | O |
|---------------|---|---|---|---|---|---|
| Arrangement A | 0 | 3 | 5 | 0 | 2 | 1 |
| Arrangement B | 4 | 0 | 3 | 7 | 0 | 0 |
| Arrangement C | 2 | 2 | 0 | 5 | 3 | 2 |

2. Arrangement A: Cost = $3(\$1.15) + 5(\$1.70) + 2(\$4) + 1(\$3) = \$22.95$
 Arrangement B: Cost = $4(\$1.50) + 3(\$1.70) + 7(\$1) = \18.10
 Arrangement C: Cost = $2(\$1.50) + 2(\$1.15) + 5(\$1) + 3(\$4) + 2(\$3) = \28.30

The cost matrix is:
$$\begin{bmatrix} \$22.95 \\ \$18.10 \\ \$28.30 \end{bmatrix} \begin{array}{l} \text{Arrangement A} \\ \text{Arrangement B} \\ \text{Arrangement C} \end{array}$$

3. Total cost =
$$\begin{bmatrix} \$22.95 \\ \$18.10 \\ \$28.30 \end{bmatrix} + \begin{bmatrix} \$2.55 \\ \$2.10 \\ \$3.05 \end{bmatrix} = \begin{bmatrix} \$25.50 \\ \$20.20 \\ \$31.35 \end{bmatrix} \begin{array}{l} \text{Arrangement A} \\ \text{Arrangement B} \\ \text{Arrangement C} \end{array}$$

4. Selling prices:
$$4 \begin{bmatrix} \$25.50 \\ \$20.20 \\ \$31.35 \end{bmatrix} = \begin{bmatrix} \$102.00 \\ \$80.80 \\ \$125.40 \end{bmatrix} \begin{array}{l} \text{Arrangement A} \\ \text{Arrangement B} \\ \text{Arrangement C} \end{array}$$

5.
$$\frac{1}{5} \begin{bmatrix} \$13.33 \\ \$12.52 \\ \$7.61 \\ \$31.50 \\ \$17.00 \\ \$11.00 \\ \$18.00 \end{bmatrix} = \begin{bmatrix} \$2.67 \\ \$2.50 \\ \$1.52 \\ \$6.30 \\ \$3.40 \\ \$2.20 \\ \$3.60 \end{bmatrix}$$

6.
$$\begin{bmatrix} \$4.00 \\ \$4.75 \\ \$2.50 \\ \$9.50 \\ \$5.75 \\ \$3.00 \\ \$5.50 \end{bmatrix} - \begin{bmatrix} \$2.67 \\ \$2.50 \\ \$1.52 \\ \$6.30 \\ \$3.40 \\ \$2.20 \\ \$3.60 \end{bmatrix} = \begin{bmatrix} \$1.33 \\ \$2.25 \\ \$0.98 \\ \$3.20 \\ \$2.35 \\ \$0.80 \\ \$1.90 \end{bmatrix}$$

7. Purchasing flowers in bundles of 5, which is much cheaper. She saves between \$0.80 and \$3.20 per stem buying in bulk. This will add up to a lot of money over time.

Independent Practice Exercises: ANSWER KEY

$$1. \begin{array}{l} \text{Arrangement A} \\ \text{Arrangement B} \end{array} \begin{array}{c} \text{B} \quad \text{H} \quad \text{L} \quad \text{I} \quad \text{S} \quad \text{R} \\ \left[\begin{array}{cccccc} 2 & 1 & 2 & 0 & 3 & 3 \\ 2 & 3 & 0 & 3 & 2 & 4 \end{array} \right] \end{array}$$

$$2. \text{Arrangement A: Cost} = 2(\$1.15) + 1(\$0.95) + 2(\$3.25) + 3(\$3) + 3(\$2.25) = \$25.50$$

$$\text{Arrangement B: Cost} = 2(\$1.15) + 3(\$0.95) + 3(\$2) + 2(\$3) + 4(\$2.25) = \$26.15$$

$$\text{Cost Matrix: } \begin{bmatrix} \$25.50 \\ \$26.15 \end{bmatrix}$$

$$3. \text{Total cost} = \begin{bmatrix} \$25.50 \\ \$26.15 \end{bmatrix} + \begin{bmatrix} \$2.45 \\ \$2.85 \end{bmatrix} = \begin{bmatrix} \$27.95 \\ \$29.00 \end{bmatrix}$$

$$4. \text{Selling price} = 3 \begin{bmatrix} \$27.95 \\ \$29.00 \end{bmatrix} = \begin{bmatrix} \$83.85 \\ \$87.00 \end{bmatrix}$$

$$5. \text{Unit price} = \frac{1}{10} \begin{bmatrix} \$13.90 \\ \$19.50 \\ \$19.50 \\ \$22.99 \\ \$37.95 \\ \$16.99 \\ \$10.44 \end{bmatrix} = \begin{bmatrix} \$1.39 \\ \$1.95 \\ \$1.95 \\ \$2.30 \\ \$3.80 \\ \$1.70 \\ \$1.04 \end{bmatrix}$$

$$6. \text{Cost difference: } \begin{bmatrix} \$2.00 \\ \$3.00 \\ \$3.75 \\ \$4.25 \\ \$5.50 \\ \$3.25 \\ \$1.50 \end{bmatrix} - \begin{bmatrix} \$1.39 \\ \$1.95 \\ \$1.95 \\ \$2.30 \\ \$3.80 \\ \$1.70 \\ \$1.04 \end{bmatrix} = \begin{bmatrix} \$0.61 \\ \$1.05 \\ \$1.80 \\ \$1.95 \\ \$1.70 \\ \$1.55 \\ \$0.46 \end{bmatrix} \begin{array}{l} \text{Snapdragon} \\ \text{Gerbera daisy} \\ \text{Orchid} \\ \text{Calla lily} \\ \text{Peony} \\ \text{Lily} \\ \text{Queen Anne's lace} \end{array}$$

7. a. $\text{Cost} = 3(\$1.95) + 3(\$1.39) + 1(\$2.30) + 2(\$3.80) = \$19.92$
- b. $\text{Cost} = 3(\$3) + 3(\$2) + 1(\$4.25) + 2(\$5.50) = \$30.25$
- c. It is cheaper for Matthew to buy the flowers in bundles of 10 from his wholesaler.

$$\text{Savings} = \$30.25 - \$19.92 = \$10.33$$

Guided Practice Exercises:

Sally is making three floral arrangements, each using a different combination of flowers. She has Queen Anne's lace, baby's breath, roses, carnations, hydrangeas, and orchids available.

- Organize the following information into a 3×6 matrix.
 - Arrangement A will have 3 stems of baby's breath, 5 roses, 2 hydrangeas, and 1 orchid.
 - Arrangement B will have 4 stems of Queen Anne's lace, 3 roses, and 7 carnations.
 - Arrangement C will have 2 stems each of Queen Anne's lace and baby's breath, 5 carnations, 3 hydrangeas, and 2 orchids.

- The following matrix shows the wholesale price (per stem) for each of the flowers used in Sally's arrangements. Use this matrix to find the cost of each arrangement, and write the cost as a 3×1 matrix.

| | |
|-------------------|--------|
| Queen Anne's lace | \$1.50 |
| Baby's breath | \$1.15 |
| Roses | \$1.70 |
| Carnations | \$1.00 |
| Hydrangeas | \$4.00 |
| Orchids | \$3.00 |

3. Sally also has to consider the cost of hardgoods before she can determine the price for each arrangement. (Hardgoods include the vase, floral preservative, oasis foam, wire, and ribbon accents.) The matrix below shows the total cost of hardgoods for each arrangement.

$$\begin{array}{l} \text{Arrangement A} \\ \text{Arrangement B} \\ \text{Arrangement C} \end{array} \begin{bmatrix} \$2.55 \\ \$2.10 \\ \$3.05 \end{bmatrix}$$

Add this matrix to the matrix you found in question 2 to obtain a matrix representing the total cost of each arrangement.

4. Sally plans to use a 4:1 ratio markup for these arrangements. Use the matrix you found in question 3 and scalar multiplication to find a matrix that represents the selling price of each arrangement.

Jordan is the owner of a flower shop and wants to know whether it is cost effective to buy flowers in bulk rather than by the individual stem. She collects some wholesale flower prices to compare.

5. Jordan starts by examining flowers that can be purchased in bundles of 5 from her wholesaler. The prices listed in the matrix below represent the cost for a bundle of 5 stems of each flower.

| | |
|------------------|---------|
| Hyacinth | \$13.33 |
| Lisianthus | \$12.52 |
| Chrysanthemum | \$7.61 |
| Hydrangea | \$31.50 |
| Bird of paradise | \$17.00 |
| Sunflower | \$11.00 |
| Dahlia | \$18.00 |

Use scalar multiplication to find the unit cost of each flower when purchased in a bundle of 5. Write your answer as a 7×1 matrix.

6. From the same wholesaler, Jordan can purchase individual stems of each of these flowers. The prices for individual stems of each type of flower are listed below.

| | |
|------------------|--------|
| Hyacinth | \$4.00 |
| Lisianthus | \$4.75 |
| Chrysanthemum | \$2.50 |
| Hydrangea | \$9.50 |
| Bird of paradise | \$5.75 |
| Sunflower | \$3.00 |
| Dahlia | \$5.50 |

Subtract the matrix you found in question 5 from this matrix to determine the difference in cost between the flowers purchased in bundles and the flowers purchased by the stem.

7. Should Jordan purchase these flowers in bundles of 5 or by the individual stem? Explain your answer.

Independent Practice Exercises:

Matthew is designing two floral arrangements. He has six types of flowers to choose from for each arrangement: baby's breath, hypericum berries, lily, iris, sweet pea, and ranuncules.

1. Organize the following information into a 2×6 matrix.
 - Arrangement A will have 2 stems of baby's breath, 1 stem of hypericum berries, 2 lilies, 3 stems of sweet pea, and 3 ranuncules.
 - Arrangement B will have 2 stems of baby's breath, 3 stems of hypericum berries, 3 irises, 2 stems of sweet pea, and 4 ranuncules.

2. The matrix below gives the price per stem for each flower Matthew will be using. Use this matrix to determine the cost of the flowers for each arrangement. Write your answer as a 2×1 matrix.

| | |
|-------------------|--------|
| Baby's breath | \$1.15 |
| Hypericum berries | \$0.95 |
| Lily | \$3.25 |
| Iris | \$2.00 |
| Sweet pea | \$3.00 |
| Ranuncules | \$2.25 |

3. Matthew must also add the cost of the hardgoods for each arrangement before he can determine a selling price. The matrix below gives the total cost of hardgoods for each arrangement.

$$\begin{array}{l} \text{Arrangement A} \\ \text{Arrangement B} \end{array} \begin{bmatrix} \$2.45 \\ \$2.85 \end{bmatrix}$$

Add this matrix to the cost matrix you found in question 2 to obtain a matrix that gives the total cost of each arrangement.

4. Matthew plans to use a 3:1 ratio markup to determine the selling price of each arrangement. Use scalar multiplication and the matrix you found in question 3 to determine the selling price of each arrangement.

Matthew wants to make his floral design business more cost effective so that he can increase his profits. He is interested in comparing the wholesale prices of flowers purchased in bundles to the prices of individual stems to determine which will save him the most money.

5. Matthew compares prices for all the flowers that can be purchased in bundles of 10 stems. The matrix below gives the prices for bundles of 10 stems of each flower.

| | |
|-------------------|---------|
| Snapdragon | \$13.90 |
| Gerbera daisy | \$19.50 |
| Orchid | \$19.50 |
| Calla lily | \$22.99 |
| Peony | \$37.95 |
| Lily | \$16.99 |
| Queen Anne's lace | \$10.44 |

Use scalar multiplication to find a matrix that represents the unit cost of each stem when purchased in a bundle of 10.

6. The matrix below gives the cost of individual stems of each flower.

| | |
|-------------------|--------|
| Snapdragon | \$2.00 |
| Gerbera daisy | \$3.00 |
| Orchid | \$3.75 |
| Calla lily | \$4.25 |
| Peony | \$5.50 |
| Lily | \$3.25 |
| Queen Anne's lace | \$1.50 |

Subtract the matrix you found in question 5 from this matrix to find the difference in cost of individual stems and stems purchased in bundles of 10. Write your answer as a 7×1 matrix.

7. Suppose Matthew is making an arrangement that requires 3 gerbera daisies, 3 snapdragons, 1 calla lily, and 2 peonies.
- Determine the cost of the flowers for this arrangement if Matthew uses flowers purchased in bundles of 10.

- b. Determine the cost of the flowers for this arrangement if Matthew uses flowers purchased by the individual stem.
- c. Which is the cheaper option? How much money will Matthew save using this option?