

## MATRICES

### ***PROBLEM 2: THE DOG WALKERS***

Max and Moritz will be going off to college in a few years. They have been attending Junior Achievement meetings and decide they would like to start their own business to earn money for college. Because they only have \$200.00 start up capital, Max and Moritz decide to start a business that offers a service.

After several weeks of observing their neighborhood, they decide that a dog walking service is needed. In addition to establishing their own web page, Max and Moritz have 200 advertisements for the M & M Dog Walkers to send to families in their neighborhood. To get the ads out in a timely manner, Max and Moritz hire three people to fold the ads, stuff and seal the envelopes, and apply the address labels they printed on their computers. They will pay \$0.03 to fold an advertisement, \$0.06 to stuff and seal an envelope, and \$0.02 to apply an address label.

Person 1 folds 58 advertisements, stuffs and seals 60 envelopes, and applies 50 address labels.

Person 2 folds 77 advertisements, stuffs and seals 72 envelopes, and applies 78 address labels.

Person 3 folds 65 advertisements, stuffs and seals 68 envelopes, and applies 72 address labels.

- A. Create a table showing the amount of work each person does.
- B. Determine how much each person will be paid. Explain how you arrived at your answer.
- C. Write a matrix representing the amount paid for each action. Label the rows and columns.
- D. Write a matrix representing the number of actions performed by each person. Label the rows and columns.
- E. Use matrix multiplication to determine how much each person will be paid. How does this answer compare with your answer from problem B?
- F. How would you explain matrix multiplication to your friend who was absent from school when you completed this activity?

## MATRICES

### **ONE SOLUTION TO PROBLEM 2: THE DOG WALKERS**

#### **A. Create a table showing the amount of work each person does.**

NOTE: The rows and columns in the table below may be transposed.

ACTION	PERSON 1	PERSON 2	PERSON 3
Fold	58	77	65
Stuff / Seal	60	72	68
Label	50	78	72

#### **B. Determine how much each person will be paid. Explain how you arrived at your answer.**

Simply multiply the amount paid for each action by the number of each action and then sum for each person.

Person 1 will be paid \$6.34 ( $58 * .03 + 60 * .06 + 50 * .02$ ).

Person 2 will be paid \$8.19 ( $77 * .03 + 72 * .06 + 78 * .02$ ).

Person 3 will be paid \$7.47 ( $65 * .03 + 68 * .06 + 72 * .02$ ).

#### **C. Write a matrix representing the number of actions performed by each person.**

**Label the rows and columns.**

Again, rows and columns could be transposed as shown below. The two possible matrices have been labeled as *C1* and *C2*.

<i>C1</i>	<b>P1</b>	<b>P2</b>	<b>P3</b>		<i>C2</i>	<b>Fold</b>	<b>Stuff/Seal</b>	<b>Label</b>
<b>Fold</b>	58	77	65		<b>P1</b>	58	60	50
<b>Stuff/Seal</b>	60	72	68		<b>P2</b>	77	72	78
<b>Label</b>	50	78	72		<b>P3</b>	65	68	72

## MATRICES

**D. Write a matrix representing the amount paid for each action. Label the rows and columns.**

The two possibilities, a one-by-three and a three-by-one, are shown below. They have been named *D1* and *D2*.

<b><i>D1</i></b>	<b>Fold</b>	<b>Stuff/Seal</b>	<b>Label</b>		<b><i>D2</i></b>	<b>Amount</b>
<b>Amount</b>	0.03	0.06	0.02		<b>Fold</b>	0.03
					<b>Stuff/Seal</b>	0.06
					<b>Label</b>	0.02

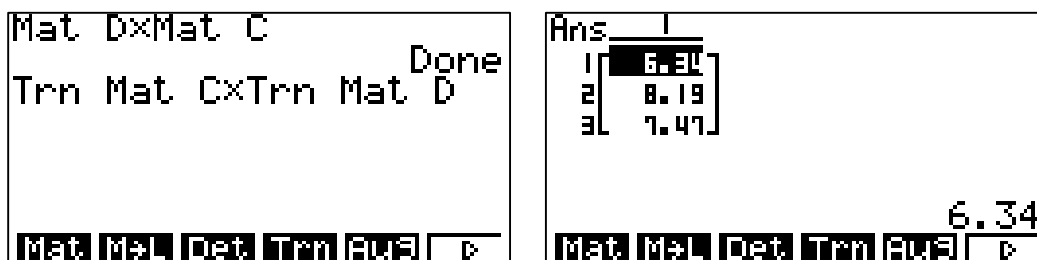
**E. Use matrix multiplication to determine how much each person will be paid. How does this answer compare with your answer from problem B?**

If we multiply *D1* by *C1* we will use the row in *D1*, the prices for each of the items, and multiply by it the numbers of items each person completed, as listed in the columns of *C1*. Alternately, we could multiply *C2* by *D2*. Because matrix multiplication is not commutative, students may have difficulty setting up the multiplication. We should, however, obtain the same answers as we did in problem B.

- x From the MAIN MENU, choose “Matrix.”
- x Make Matrix C a three-by-three matrix and enter matrix *C1* shown above, pressing EXE after each entry. Press EXIT when finished.
- x Make matrix D a one-by-three matrix as shown in *D1*, again pressing EXE after each entry. Press EXIT when finished.
- x Press MENU and choose “Run” from the MAIN MENU. Also press OPTN and F2 for matrix options to be available.
- x Using F1 before the matrix name, tell the calculator to calculate Matrix D times Matrix C. Alternatively, tell the calculator to multiply the transpose of Matrix C (use F4 for the transpose) times the transpose of Matrix D. See below left for the two possible ways to enter this.

## MATRICES

x Press **EXE** with whatever operation you have chosen. See below right.



The answers should be the same as those we obtained in problem B.

**F. How would you explain matrix multiplication to your friend who was absent from school when you completed this activity?**

Answer will vary. What is important for students to work on is matching the rows in the left matrix with the columns in the right matrix.