Lesson 20: Writing and Evaluating Expressions—Multiplication and Division

Student Outcomes

- Students develop expressions involving multiplication and division from real-world problems.
- Students evaluate these expressions for given values.

Lesson Notes

This lesson builds on Lesson 18 and 19, extending the concepts using multiplication and division expressions.

Classwork

Opening (3 minutes)

Take time to make sure the answers to the Problem Set from the previous lesson are clear. The labels on the tables should be complete.

Discussion (3 minutes)

- In the previous lessons, we created expressions that used addition and subtraction to describe the relationship between two quantities. How did using tables help your understanding?
    - *Answers will vary. Patterns were easy to see. Looking down the columns revealed a number pattern. Looking across the rows revealed a constant difference between columns.*
- In this lesson, we are going to develop expressions involving multiplication and division, much like the last lesson. We will also evaluate these expressions for given values.

Example 1 (10 minutes)

- The farmers' market is selling bags of apples. In every bag, there are 3 apples. If I buy one bag, how many apples will I have?
    - *Three.*
- If I buy two bags, how many apples will I have?
    - *Since* $2 \cdot 3 = 6$*, you will have* 6 *apples.*
- If I buy three bags, how many apples will I have?
    - *Since* $3 \cdot 3 = 9$*, you will have* 9 *apples.*
- Fill in the table for a purchase of 4 bags of apples. Check your answer with a partner.

Scaffolding:

Having interlocking cubes ready in groups of three will make a concrete visual for students to see and hold for Example 1. Put these in clear plastic bags, if desired.

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Example 1

1. **The farmers' market is selling bags of apples. In every bag, there are 3 apples.**

   a. **Complete the table.**

Number of Bags	Total Number of Apples
1	3
2	6
3	9
4	12
B	$3B$

- What if I bought some other number of bags? If I told you how many bags, could you calculate the number of apples I would have altogether?
  - *Yes, multiply the number of bags by 3 to find the total number of apples.*
- What if I bought B bags of apples? Can you write an expression in the table that describes the total number of apples I have purchased?
  - $3B$ *or* $3(B)$ *or* $3 \cdot B$

Take a moment to review the different notations used for multiplication. Students should be comfortable reading and writing the expressions in all three forms.

- What if the market had 25 bags of apples to sell? How many apples is that in all?
  - *If* $B = 25$, *then* $3B = 3 \cdot 25 = 75$ *apples.*

b. **What if the market had 25 bags of apples to sell? How many apples is that in all?**

If $B = 25$, then $3B = 3 \cdot 25 = 75$ apples.

c. **If a truck arrived that had some number, a, more apples on it, then how many bags would the clerks use to bag up the apples?**

$a \div 3$ bags are needed. If there are 1 or 2 apples left over, an extra bag will be needed (although not full).

d. **If a truck arrived that had 600 apples on it, how many bags would the clerks use to bag up the apples?**

$600 \text{ apples} \div \dfrac{3 \text{ apples}}{1 \text{ bag}} = 200 \text{ bags}.$

e. **How is part (d) different from part (b)?**

Part (d) gives the number of apples and asks for the number of bags. Therefore, we needed to divide the number of apples by 3. Part (b) gives the number of bags and asks for the number of apples. Therefore, we needed to multiply the number of bags by 3.

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Exercise 1 (5 minutes)

Students work on Exercise 1 independently.

Exercises

1. **In New York State, there is a five cent deposit on all carbonated beverage cans and bottles. When you return the empty can or bottle, you get the five cents back.**

   a. **Complete the table.**

Number of Containers Returned	Refund in Dollars
1	0.05
2	0.10
3	0.15
4	0.20
10	0.50
50	2.50
100	5.00
C	$0.05C$

   b. **If we let C represent the number of cans, what is the expression that shows how much money is returned?**

   $0.05C$.

   c. **Use the expression to find out how much money Brett would receive if he returned 222 cans.**

   If $C = 222$, then $0.05C = 0.05 \cdot 222 = 11.10$. Brett would receive $\$11.10$ if he returned 222 cans.

   d. **If Gavin needs to earn $\$4.50$ for returning cans, how many cans does he need to collect and return?**

   $\$4.50 \div 0.05 = 90$ cans.

   e. **How is part (d) different from part (c)?**

   Part (d) gives the amount of money and asks for the number of cans. Therefore, we needed to divide the amount of money by 0.05. Part (c) gives the number of cans and asks for the amount of money. Therefore, we needed to multiply the number of cans by 0.05.

Discuss the similarities and differences between Example 1 and Exercise 1. In both problems, the second quantity is a multiple of the first. Multiplication by the constant term is used to show the relationship between the quantities in the first column and the quantities in the second column. Division is used to show the relationship between the quantities in the second column and the quantities in the first column.

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Exercise 2 (10 minutes)

Students work on Exercise 2 independently.

2. The fare for a subway or a local bus ride is $\$2.50$.

a. Complete the table.

Number of Rides	Cost of Rides in Dollars
1	2.50
2	5.00
3	7.50
4	10.00
5	12.50
10	25.00
30	75.00
R	$2.50R$ *or* $2.5R$

b. If we let R represent the number of rides, what is the expression that shows the cost of the rides?

$2.50R$ *or* $2.5R$

c. Use the expression to find out how much money 60 rides would cost.

If $R = 60$*, then* $2.50R = 2.50 \cdot 60 = \$150.00$.

d. If a commuter spends $\$175.00$ on subway or bus rides, how many trips did the commuter take?

$175.00 \div 2.50 = 70$. *The commuter took* 70 *trips.*

e. How is part (d) different from part (c)?

Part (d) gives the amount of money and asks for the number of rides. Therefore, we needed to divide the amount of money by the cost of each ride ($\$2.50$*). Part (c) gives the number of rides and asks for the amount of money. Therefore, we needed to multiply the number of rides by* $\$2.50$.

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Exercise 3 (10 minutes): Challenge Problem

Challenge Problem

3. A pendulum swings though a certain number of cycles in a given time. Owen made a pendulum that swings 12 times every 15 seconds.

a. Construct a table showing the number of cycles through which a pendulum swings. Include data for up to one minute. Use the last row for C cycles, and write an expression for the time it takes for the pendulum to make C cycles.

Number of Cycles	*Time in Seconds*
12	15
24	30
36	45
48	60
C	$\frac{15C}{12}$

b. Owen and his pendulum team set their pendulum in motion and counted 16 cycles. What was the elapsed time?

$C = 16; \frac{15 \cdot 16}{12} = 20$. *The elapsed time is 20 seconds.*

c. Write an expression for the number of cycles a pendulum swings in S seconds.

$\frac{12}{15}S$ *or* $\frac{4}{5}S$ *or* $0.8 \cdot S$

d. In a different experiment, Owen and his pendulum team counted the cycles of the pendulum for 35 seconds. How many cycles did they count?

$S = 35; 0.8 \cdot 35 = 28$. *They counted 28 cycles.*

Closing (2 minutes)

- In Example 1, we looked at the relationship between the number of bags purchased at the farmers' market and the total number of apples purchased. We created two different expressions: $3B$ and $a \div 3$. What does each variable represent, and why did we multiply by 3 in the first expression and divide by 3 in the second?
  - *The variable B represented the number of bags. We had to multiply by 3 because we were given the number of bags and there were 3 apples packaged in each bag. The variable a represented the number of apples. We divided by 3 because we were given the number of apples and need to determine the number of bags needed.*
- What would the expressions be if the farmers' market sold bags that contained 5 apples in a bag instead of 3?
  - *$5B$ and $a \div 5$, respectively.*

Exit Ticket (3 minutes)

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Name ______________________________ Date ______________

Lesson 20: Writing and Evaluating Expressions—Multiplication and Division

Exit Ticket

Anna charges $\$8.50$ per hour to babysit. Complete the table, and answer the questions below.

Number of Hours	Amount Anna Charges in Dollars
1	
2	
5	
8	
H	

a. Write an expression describing her earnings for working H hours.

b. How much will she earn if she works for $3\frac{1}{2}$ hours?

c. How long will it take Anna to earn $\$51.00$?

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Exit Ticket Sample Solutions

1. Anna charges $\$8.50$ per hour to babysit. Complete the table and answer the questions below.

Number of Hours	Amount Anna Charges in Dollars
1	8.50
2	17.00
5	42.50
8	68
H	$8.50H$ *or* $8.5H$

   a. Write an expression describing her earnings for working H hours.

   $8.50H$ *or* $8.5H$

   b. How much will she earn if she works for $3\frac{1}{2}$ hours?

   If $H = 3.5$, *then* $8.5H = 8.5 \cdot 3.5 = 29.75$. *She will earn* $\$29.75$.

   c. How long will it take Anna to earn $\$51.00$?

   $51 \div 8.5 = 6$. *It will take Anna* 6 *hours to earn* $\$51.00$.

Problem Set Sample Solutions

1. A radio station plays 12 songs each hour. They never stop for commercials, news, weather, or traffic reports.

   a. Write an expression describing how many songs are played by the radio station in H hours.

   $12H$

   b. How many songs will be played in an entire day (24 hours)?

   $12 \cdot 24 = 288$. *There will be* 288 *songs played.*

   c. How long does it take the radio station to play 60 consecutive songs?

   $$60 \text{ songs} \div \frac{12 \text{ songs}}{1 \text{ hour}} = 5 \text{ hours}$$

2. A ski area has a high speed lift that can move $2,400$ skiers to the top of the mountain each hour.

   a. Write an expression describing how many skiers can be lifted in H hours.

   $2,400H$

   b. How many skiers can be moved to the top of the mountain in 14 hours?

   $14 \cdot 2,400 = 33,600$. $33,600$ *skiers can be moved.*

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c. How long will it take to move $3,600$ skiers to the top of the mountain?

$3,600 \div 2,400 = 1.5$. *It will take an hour and a half to move $3,600$ skiers to the top of the mountain.*

3. Polly writes a magazine column, for which she earns $\$35$ per hour. Create a table of values that shows the relationship between the number of hours that Polly works, H, and the amount of money Polly earns in dollars, E.

Answers will vary. Sample answers are shown.

Hours Polly Works (H)	*Polly's Earnings in Dollars* (E)
1	35
2	70
3	105
4	140

a. If you know how many hours Polly works, can you determine how much money she earned? Write the corresponding expression.

Multiplying the number of hours that Polly works by her rate ($\$35$ per hour) will calculate her pay. $35H$ is the expression for her pay in dollars.

b. Use your expression to determine how much Polly earned after working for $3\frac{1}{2}$ hours.

$35H = 35 \cdot 3.5 = 122.5$. *Polly makes $\$122.50$ for working $3\frac{1}{2}$ hours.*

c. If you know how much money Polly earned, can you determine how long she worked? Write the corresponding expression.

Dividing Polly's pay by 35 will calculate the number of hours she worked. $E \div 35$ is the expression for the number of hours she worked.

d. Use your expression to determine how long Polly worked if she earned $\$52.50$.

$52.50 \div 35 = 1.5$; *Polly worked an hour and a half for $\$52.50$.*

4. Mitchell delivers newspapers after school, for which he earns $\$0.09$ per paper. Create a table of values that shows the relationship between the number of papers that Mitchell delivers, P, and the amount of money Mitchell earns in dollars, E.

Answers will vary. Sample answers are shown.

Number of Papers Delivered (P)	*Mitchell's Earnings in Dollars* (E)
1	0.09
10	0.90
100	9.00
1000	90.00

a. If you know how many papers Mitchell delivered, can you determine how much money he earned? Write the corresponding expression.

Multiplying the number of papers that Mitchell delivers by his rate ($\$0.09$ per paper) will calculate his pay. $0.09P$ is the expression for his pay in dollars.

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b. Use your expression to determine how much Mitchell earned by delivering 300 newspapers.

$0.09P = 0.09 \cdot 300 = 27$. *Mitchell earned* $\$27.00$ *for delivering* 300 *newspapers.*

c. If you know how much money Mitchell earned, can you determine how many papers he delivered? Write the corresponding expression.

Dividing Mitchell's pay by $\$0.09$ *will calculate the number of papers he delivered.* $E \div 0.09$ *is the expression for the number of papers he delivered.*

d. Use your expression to determine how many papers Mitchell delivered if he earned $\$58.50$ last week.

$58.50 \div 0.09 = 650$*; therefore, Mitchell delivered* 650 *newspapers last week.*

5. Randy is an art dealer who sells reproductions of famous paintings. Copies of the *Mona Lisa* sell for $\$475$.

a. Last year Randy sold $\$9,975$ worth of *Mona Lisa* reproductions. How many did he sell?

$9,975 \div 475 = 21$. *He sold* 21 *copies of the painting.*

b. If Randy wants to increase his sales to at least $\$15,000$ this year, how many copies will he need to sell (without changing the price per painting)?

$15,000 \div 475$ *is about* 31.6. *He will have to sell* 32 *paintings in order to increase his sales to at least* $\$15,000$.

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