

Student Outcomes

- Students use their knowledge of simplifying expressions, order of operations, and properties of equality to
 calculate the solution of multi-step equations. Students use tables to determine their answer.
- Students check to determine if their solution makes the equation true.

Classwork

Example 1 (20 minutes)

Students participate in the discussion by answering the teacher's questions and following along in their student materials.

Example 1

The school librarian, Mr. Marker, knows the library has 1,400 books but wants to reorganize how the books are displayed on the shelves. Mr. Marker needs to know how many fiction, nonfiction, and resource books are in the library. He knows that the library has four times as many fiction books as resource books and half as many nonfiction books as fiction books. If these are the only types of books in the library, how many of each type of book are in the library?

MP.1

Give students time to work individually or with a partner in order to attempt to make sense of the problem. Students may attempt to solve the problem on their own prior to the following discussion.

Draw a tape diagram to represent the total number of books in the library.				
1,400				
Draw two more tape diagrams, one to represent the number of fiction books in the library and one to represent the number of resource books in the library.				
Resource Books:				
Fiction Books:				
What variable should we use throughout the problem?				
We should use r to represent the number of resource books in the library because it represents the fewest amount of books. Choosing the variable to represent a different type of book would create fractions throughout the problem.				
Write the relationship between resource books and fiction books algebraically.				
If we let r represent the number of resource books, then $4r$ represents the number of fiction books.				
Draw a tape diagram to represent the number of nonfiction books.				
Nonfiction Books:				



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How did you dec	de how many sections this tape diagram would have?				
There are half as many nonfiction books as fiction books. Since the fiction book tape diagram has four sections, the nonfiction book tape diagram should have two sections.					
Represent the nu	mber of nonfiction books in the library algebraically.				
2r because that	is half as many as fiction books ($4r$).				
Use the tape dia We know that co	grams we drew to solve the problem. mbining the tape diagrams for each type of book will leave us with 1, 4	00 total books.			
	1,400				
r	4 <i>r</i>	2r			
Write an equatio	n that represents the tape diagram.				
4r + 2r + r = 1	4r + 2r + r = 1,400				
Determine the value of r.					
We can gather li	e terms, and then solve the equation.				
	7r = 1,400				
	$7r \div 7 = 1,400 \div 7$				
	r = 200				

- What does this 200 mean?
 - There are 200 resource books in the library because *r* represented the number of resource books.

How many fiction books are in the library?
There are 800 fiction books in the library because $4(200) = 800$.
How many nonfiction books are in the library?
There are 400 nonfiction books in the library because $2(200) = 400$.

We can use a different math tool to solve the problem as well. If we were to make a table, how many columns would we need?

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- Why do we need four columns?
 - We need to keep track of the number of fiction, nonfiction, and resource books that are in the library, but we also need to keep track of the total number of books.

Set up a table with four columns and label each column.						
	Fiction Nonfiction Resource Total					



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- Highlight the important information from the word problem that will help us fill out the second row in our table.
 - The school librarian, Mr. Marker, knows the library has 1,400 books but wants to reorganize how the books are displayed on the shelves. Mr. Marker needs to know how many fiction, nonfiction, and resource books are in the library. He knows that the library has four times as many fiction books as resource books and half as many nonfiction books as fiction books. If these are the only types of books in the library, how many of each type of book are in the library?
- Fill out the second row of the table using the algebraic representations.

Fiction	Nonfiction	Resource	Total
4 <i>r</i>	2 <i>r</i>	r	7 <i>r</i>

If r = 1, how many of each type of book would be in the library?

Fiction	Nonfiction	Resource	Total
4 <i>r</i>	2 <i>r</i>	r	7 <i>r</i>
4	2	1	7

- How can we fill out another row of the table?
 - Substitute different values in for r.
- Substitute 5 in for r. How many of each type of book would be in the library then?

Fiction	Nonfiction	Resource	Total
4	2	1	7
20	10	5	35

- Does the library have four times as many fiction books as resource books?
 - Yes, because $5 \cdot 4 = 20$.
- Does the library have half as many nonfiction books as fiction books?
 - Yes, because half of 20 is 10.
- How do we determine how many of each type of book is in the library when there are 1,400 books in the library?
 - Continue to multiply the rows by the same value, until the total column has 1,400 books.

At this point, allow the students to work individually to determine how many fiction, nonfiction, and resource books are in the library if there are 1,400 total books. Each table may look different because students may choose different values to multiply by. A sample answer is shown below.

Fiction	Nonfiction	Resource	Total
4	2	1	7
20	10	5	35
200	100	50	350
800	400	200	1.400

800



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6•4





How many nonfiction books are in the library? 400

How many resource books are in the library?

Let us check and make sure that our answers fit the relationship described in the word problem.



Exercises 1–4 (15 minutes)

Students work in small groups to answer the following problems using tables and algebraic methods.

Exercises 1–4

Solve each problem below using tables and algebraic methods. Then, check your answer with the word problem.

1. Indiana Ridge Middle School wanted to add a new school sport, so they surveyed the students to determine which sport is most popular. Students were able to choose among soccer, football, lacrosse, or swimming. The same number of students chose lacrosse and swimming. The number of students who chose soccer was double the number of students who chose lacrosse. The number of students who chose football was triple the number of students who chose swimming. If 434 students completed the survey, how many students chose each sport?

Soccer	Football	Lacrosse	Swimming	Total	
2	3	1	1	7	
The rest of the table will vary.					

Soccer	Football	Lacrosse	Swimming	Total
2	3	1	1	7
124	186	62	62	434

124 students chose soccer, 186 students chose football, 62 students chose lacrosse, and 62 students chose swimming.

We can confirm that these numbers satisfy the conditions of the word problem because lacrosse and swimming were chosen by the same number of students. 124 is double 62, so soccer was chosen by double the number of students as lacrosse, and 186 is triple 62, so football was chosen by 3 times as many students as swimming. Also, 124 + 186 + 62 + 62 = 434.

Algebraically: Let *s* represent the number of students who chose swimming. Then, 2*s* is the number of students who chose soccer, 3*s* is the number of students who chose football, and *s* is the number of students who chose lacrosse.

2s + 3s + s + s = 434 7s = 434 $7s \div 7 = 434 \div 7$ s = 62

Therefore, 62 students chose swimming and 62 students chose lacrosse. 124 students chose soccer because 2(62) = 124, and 186 students chose football because 3(62) = 186.



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2. At Prairie Elementary School, students are asked to pick their lunch ahead of time so the kitchen staff will know what to prepare. On Monday, 6 times as many students chose hamburgers as chose salads. The number of students who chose lasagna was one third the number of students who chose hamburgers. If 225 students ordered lunch, how many students chose each option if hamburger, salad, and lasagna were the only three options?

Hamburger	Salad	Lasagna	Total
6	1	2	9

The rest of the table will vary.

Hamburger	Salad	Lasagna	Total
6	1	2	9
150	25	50	225

150 students chose a hamburger for lunch, 25 students chose a salad, and 50 students chose lasagna.

We can confirm that these numbers satisfy the conditions of the word problem because $25 \cdot 6 = 150$, so hamburgers were chosen by 6 times more students than salads. Also, $\frac{1}{3} \cdot 150 = 50$, which means lasagna was chosen by one third of the number of students who chose hamburgers. Finally, 150 + 25 + 50 = 225, which means 225 students completed the survey.

Algebraically: Let *s* represent the number of students who chose a salad. Then 6*s* represents the number of students who chose hamburgers, and 2*s* represents the number of students who chose lasagna.

$$6s + s + 2s = 225$$

$$9s = 225$$

$$9s \div 9 = 225 \div 9s$$

$$s = 25$$

This means that 25 students chose salad, 150 students chose hamburgers because 6(25) = 150, and 50 students chose lasagna because 2(25) = 50.

MP.1

COMMON CORE





3. The art teacher, Mr. Gonzalez, is preparing for a project. In order for students to have the correct supplies, Mr. Gonzalez needs 10 times more markers than pieces of construction paper. He needs the same number of bottles of glue as pieces of construction paper. The number of scissors required for the project is half the number of pieces of construction paper. If Mr. Gonzalez collected 400 items for the project, how many of each supply did he collect?

Markers	Construction Paper	Glue Bottles	Scissors	Total
20	2	2	1	25

The rest of the table will vary.

Markers	Construction Paper	Glue Bottles	Scissors	Total
20	2	2	1	25
320	32	32	16	400

Mr. Gonzalez collected 320 markers, 32 pieces of construction paper, 32 glue bottles, and 16 scissors for the project.

We can confirm that these numbers satisfy the conditions of the word problem because Mr. Gonzalez collected the same number of pieces of construction paper and glue bottles. Also, $32 \cdot 10 = 320$, so Mr. Gonzalez collected 10 times more markers than pieces of construction paper and glue bottles. Mr. Gonzalez only collected 16 pairs of scissors, which is half of the number of pieces of construction paper. The supplies collected add up to 400 supplies, which is the number of supplies indicated in the word problem.

Algebraically: Let s represent the number of scissors needed for the project, which means 20s represents the number of markers needed, 2s represents the number of construction paper needed, and 2s represents the number of glue bottles needed.

$$s + 2s + 2s + s = 400$$

$$\frac{25s}{25s} = 400$$

$$\frac{25s}{25} = \frac{400}{25}$$

$$s = 16$$

This means that 16 pairs of scissors, 320 markers, 32 pieces of construction paper, and 32 glue bottles are required for the project.

4. The math teacher, Ms. Zentz, is buying appropriate math tools to use throughout the year. She is planning on buying twice as many rulers as protractors. The number of calculators Ms. Zentz is planning on buying is one quarter of the number of protractors. If Ms. Zentz buys 65 items, how many protractors does Ms. Zentz buy?

20

Rulers	Protractors	Calculators	Total
8	4	1	13

The rest of the table will vary.

Rulers	Protractors	Calculators	Total
8	4	1	13
40	20	5	65

Ms. Zentz will buy 20 protractors.

We can confirm that this number satisfies the conditions of the word problem because the number of protractors is half of the number of rulers, and the number of calculators is one fourth of the number of protractors. Also, 40 + 20 + 5 = 65, so the total matches the total supplies that Ms. Zentz bought.

Algebraically: Let c represent the number of calculators Ms. Zentz needs for the year. Then 8c represents the number of rulers, and 4c represents the number of protractors Ms. Zentz will need throughout the year.

$$8c + 4c + c = 65$$

$$13c = 65$$

$$\frac{13c}{13} = \frac{65}{13}$$

$$c = 5$$

Therefore, Ms. Zentz will need 5 calculators, 40 rulers, and 20 protractors throughout the year.



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Allow time to answer student questions and discuss answers. In particular, encourage students to compare solution methods with one another, commenting on the accuracy and efficiency of each.

Closing (5 minutes)

- Pam says she only needed two rows in her table to solve each of the problems. How was she able to do this?
 - Answers will vary. Pam only needed two rows on her table because she found the scale factor from the total in the first row and the total given in the problem. Once this scale factor is determined, it can be used for all the columns in the table because each table is a ratio table.
- Is there a more efficient way to get to the answer than choosing random values by which to multiply each row?
 - Find out how many groups of one set of materials it will take to obtain the total amount desired. Then, multiply the entire row by this number.

Students may need to see a demonstration to fully understand the reasoning. Use the exercises to further explain.

Relate this problem-solving strategy to the ratio tables discussed throughout Module 1.

Exit Ticket (5 minutes)







Name

Date

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Exit Ticket

Solve the problem using tables and equations, and then check your answer with the word problem. Try to find the answer only using two rows of numbers on your table.

A pet store owner, Byron, needs to determine how much food he needs to feed the animals. Byron knows that he needs to order the same amount of bird food as hamster food. He needs four times as much dog food as bird food and needs half the amount of cat food as dog food. If Byron orders 600 packages of animal food, how much dog food does he buy? Let *b* represent the number of packages of bird food Byron purchased for the pet store.









Exit Ticket Sample Solutions

Solve the problem using tables and equations, and then check your answer with the word problem. Try to find the answer only using two rows of numbers on your table.

A pet store owner, Byron, needs to determine how much food he needs to feed the animals. Byron knows that he needs to order the same amount of bird food as hamster food. He needs four times as much dog food as bird food and needs half the amount of cat food as dog food. If Byron orders 600 packages of animal food, how much dog food does he buy? Let *b* represent the number of packages of bird food Byron purchased for the pet store.

Bird Food	Hamster Food	Dog Food	Cat Food	Total
1	1	4	2	8

The rest of the table will vary (unless they follow suggestions from the Closing).

Bird Food	Hamster Food	Dog Food	Cat Food	Total
1	1	4	2	8
75	75	300	150	600

Byron would need to order 300 packages of dog food.

The answer makes sense because Byron ordered the same amount of bird food and hamster food. The table also shows that Byron order four times as much dog food as bird food, and the amount of cat food he ordered is half the amount of dog food. The total amount of pet food Byron ordered was 600 packages, which matches the word problem.

Algebraically: Let b represent the number of packages of bird food Byron purchased for the pet store. Therefore, b also represents the amount of hamster food, 4b represents the amount of dog food, and 2b represents the amount of cat food required by the pet store.

b + b + 4b + 2b = 6008b = 600 $8b \div 8 = 600 \div 8$ b = 75

Therefore, Byron will order 75 pounds of bird food, which results in 300 pounds of dog food because 4(75) = 300.

Problem Set Sample Solutions

Solve the problems, and then check your answers with the word problem.

- 1. On average, a baby uses three times the number of large diapers as small diapers and double the number of medium diapers as small diapers.
 - a. If the average baby uses 2,940 diapers size large and small, how many of each size would be used?

Small	Medium	Large	Total
1	2	3	6
490	980	1,470	2,940

An average baby would use 490 small diapers, 980 medium diapers, and 1,470 large diapers.

The answer makes sense because the number of large diapers is 3 times more than small diapers. The number of medium diapers is double the number of small diapers, and the total number of diapers is 2,940.



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	b.	Support your answe	r with equations.						
		Let s represent the diapers, and 3s rep	number of small die resents the amoun	apers a baby needs. t of large diapers a	Therefore, 2s repr baby needs.	esents the number of med	ium		
		s + 2s + 3s = 2,940 6s = 2,940 6s = 2940							
				6	= <u>6</u>				
				<i>s</i> =	= 490				
		Therefore, a baby ro large diapers (becau	equires $490 \text{ small } c$ use $3(490) = 1,47$	liapers, 980 mediu 70), which matches	m diapers (because the answer in part (2(490) = 980), and 1,47 (a).	'0		
2.	Tom	has three times as ma	ny pencils as pens	but has a total of $f 1$ (00 writing utensils.				
	a.	How many pencils d	oes Tom have?						
		Pencils		Pens	Total				
		3		1	4				
		75		25	100				
	b.	How many more per	ncils than pens doe	s Tom have?					
		75 - 25 = 50. Ton	n has 50 more pend	cils than pens.					
3.	Serer many	na's mom is planning h plates as cups. The r	ner birthday party. number of balloons	She bought balloor Serena's mom bou	ns, plates, and cups. ght was half the nur	Serena's mom bought tw nber of cups.	ice as		
	а.	If Serena's mom bou	ıght 84 items, how	many of each item	did she buy?	•			
		Palloons	Diator		Cupe	Total			
		1	4	, , , , , , , , , , , , , , , , , , ,	2	7			
		12	48		24	84			
		Serena's mom boug	ht 12 balloons, 48	plates, and 24 cups					
	b.	Tammy brought 12	balloons to the par	tv. How many tota	l balloons were at S	erena's birthday party?			
		40 - 40 - 04 -		· · · · · · ·					
		12 + 12 = 24. The	re were 24 total bo	alloons at the party.					
	c.	If half the plates and	l all but four cups v	vere used during the	e party, how many p	plates and cups were used	?		
		$\frac{1}{2} \cdot 48 = 24$. Twen	ty-four plates were	used during the pa	rty.				
		24 - 4 = 20. Twen	ty cups were used	during the party.					
4.	Elizat earrii	beth has a lot of jewel ngs. Elizabeth has the	ry. She has four tin same number of n	nes as many earring ecklaces as bracelet	gs as watches but ha ts.	If the number of necklace	s as		
	a.	If Elizabeth has 117	pieces of jewelry, I	how many earrings	does she have?				
		Earrings	Watches	Necklaces	Bracelets	Total			
		4	1	2	2	9			
		52	13	26	26	117			
		Elizabeth has 52 earrings, 13 watches, 26 necklaces, and 26 bracelets.							



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