

Unit **6**

Multiplying and Dividing Multi-Digit Numbers

Essential Questions

- What strategies can you use to multiply and divide multi-digit numbers?
- What are some different ways to interpret remainders in division?



Unit Story: Special Day, Special Lei

You can read the Unit Story with your student by visiting the Unit Story page on the Caregiver Hub.



Unit Investigation

Lesson 1 is the Unit Investigation. Students use equal groups to explore strategies for multiplying and dividing multi-digit numbers to build curiosity and apply their own knowledge in a variety of ways. Use the **Caregiver Connection** to help students continue to explore the math they will see in the unit.

Caregiver Connection

Students may enjoy looking for objects at home that are in equal groups, such as socks in a drawer or pairs of shoes, and consider how many there could be in total and different ways they could be organized.

Summary | Lesson 2

When multiplying multi-digit numbers, you can use the Distributive Property to rewrite one of the factors as a sum and multiply each of the addends by the other factor.

$$\begin{array}{r} 4 \times 29 \\ 4 \times (20 + 9) \\ \begin{array}{|c|c|} \hline 20 & 9 \\ \hline \end{array} \\ \begin{array}{|c|c|} \hline 4 & 4 \\ \hline \end{array} \begin{array}{|c|c|} \hline 4 \times 20 = 80 & 4 \times 9 = 36 \\ \hline \end{array} \\ \hline 80 + 36 = 116 \end{array}$$

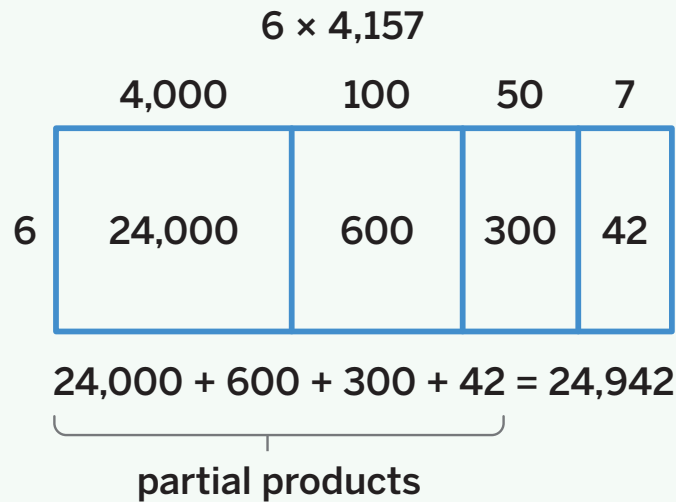
Try This

- 1** Diego picked 8 flowers from 15 different plants to make lei. Which expressions could Diego use to determine how many flowers he picked? Select *all* that apply.

- ☐ (A) 8×15
- ☐ (B) $15 + 15 + 15 + 15 + 15 + 15 + 15 + 15$
- ☐ (C) $80 + 30$
- ☐ (D) $40 + 80$
- ☐ (E) $(8 \times 10) + (8 \times 5)$

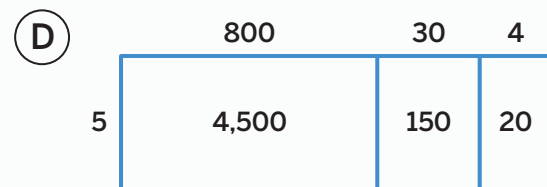
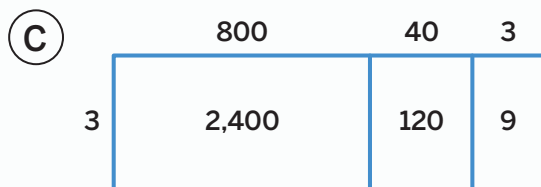
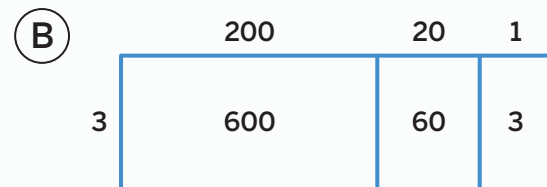
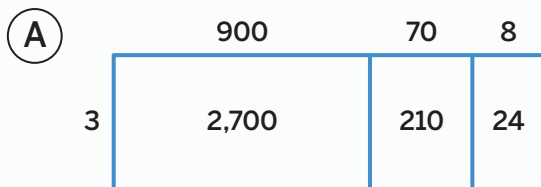
Summary | Lesson 3

Decomposing by place value and using the expanded form of a multi-digit factor is a useful strategy for multiplying. The products you get from multiplying the addends and the factor are called **partial products** and are added together to get the final product.



Try This

1 Which area diagram could be used to determine the value of 3×843 ?



Summary | Lesson 4

When multiplying with multi-digit numbers, you can estimate the product and use your estimate to determine whether your final answer is reasonable.

$$6,409 \times 5$$

$$\text{estimate: } 5 \times 6,000 = 30,000$$

	6,000	400	9
5	$5 \times 6,000$ 30,000	5×400 2,000	5×9 45

$$30,000 + 2,000 + 45 = 32,045$$

32,045 is close to 30,000, so my answer is reasonable.

Try This

- 1 Estimate the product 3×734 .



Show your thinking.

answer: _____

Summary | Lesson 5

When multiplying, you can use area diagrams, equations, or expressions to represent partial products strategies.

$$342 \times 4$$

Representations		
300 40 2 4 1,200 160 8 $1,200 + 160 + 8 = 1,368$	$300 \times 4 = 1,200$ $40 \times 4 = 160$ $2 \times 4 = 8$ $1,200 + 160 + 8 = 1,368$	$\begin{array}{r} 342 \\ \times 4 \\ \hline 8 \\ 160 \\ + 1,200 \\ \hline 1,368 \end{array}$ 4×2 4×40 4×300

Try This

- Determine the product 365×7 using the partial products algorithm.

Show your thinking.

answer: _____

Summary | Lesson 6

You can multiply 2 two-digit numbers using the same strategies you used to multiply other multi-digit numbers.

6×375	37×65
$6 \times 300 = 1,800$ $6 \times 70 = 420$ $6 \times 5 = 30$ $1,800 + 420 + 30 = 2,250$	$30 \times 60 = 1,800$ $30 \times 5 = 150$ $7 \times 60 = 420$ $7 \times 5 = 35$ $1,800 + 150 + 420 + 35 = 2,405$

Try This

- 1 Jada has a flower garden that is 15 feet by 25 feet. Shawn has a flower garden that is 18 feet by 23 feet. Who has a larger flower garden? Explain your thinking.

Summary | Lesson 7

When multiplying 2 two-digit numbers, it is helpful to decompose each number by place value to determine the partial products. You can keep track of your partial products and expressions with an area diagram.

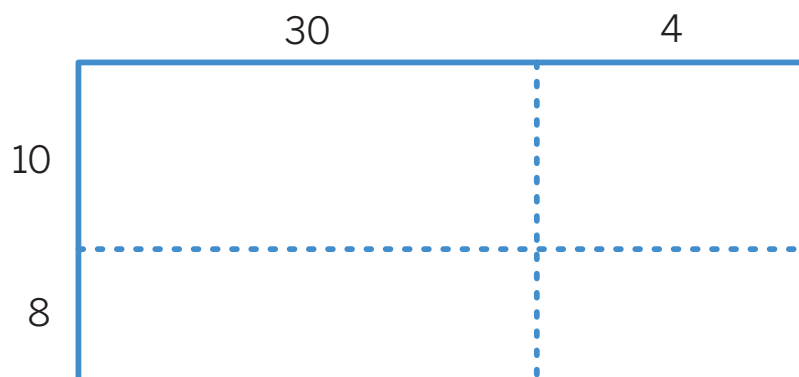
$$42 \times 35$$

	40	2
30	$30 \times 40 = 1,200$	$30 \times 2 = 60$
5	$5 \times 40 = 200$	$5 \times 2 = 10$

$$1,200 + 200 + 60 + 10 = 1,470$$

Try This

- 1 The area diagram represents 34×18 . Complete the diagram to show the partial products. Then determine the product.



answer: _____

Summary | Lesson 8

There are many strategies that can be used to multiply 2 two-digit numbers. It is important to pay attention to the place value of each digit being multiplied to determine the partial products.

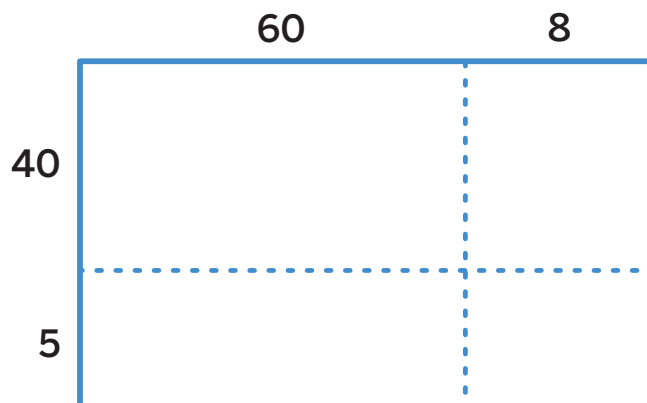
$$32 \times 19$$

Strategies		
30 2 10 30 × 10 = 300 2 × 10 = 20 9 30 × 9 = 270 2 × 9 = 18 300 + 20 + 270 + 18 = 608	$ \begin{array}{l} 30 \times 10 = 300 \\ 30 \times 9 = 270 \\ 2 \times 10 = 20 \\ 2 \times 9 = 18 \\ \\ 300 + 270 + \\ 20 + 18 = 608 \end{array} $	$ \begin{array}{r} 32 \\ \times 19 \\ \hline 18 \\ 270 \\ 20 \\ + 300 \\ \hline 608 \end{array} $ 9×2 9×30 10×2 10×30

Try This

- Complete the area diagram to determine the value of 68×45 .

 Show your thinking.



answer: _____

Summary | Lesson 9

You can use what you know about multiplying with multi-digit numbers to solve real-world problems.

There are 6 baskets with 748 flowers in each basket. How many total flowers are there?

$$\begin{aligned} &748 \times 6 \\ &700 \times 6 = 4,200 \\ &40 \times 6 = 240 \\ &8 \times 6 = 48 \\ &4,200 + 240 + 48 = 4,488 \end{aligned}$$

There are 4,488 total flowers.

A garden is 74 inches long and 86 inches wide. What is the area of the garden?

$$\begin{aligned} &74 \times 86 \\ &6 \times 4 = 24 \\ &6 \times 70 = 420 \\ &80 \times 4 = 320 \\ &80 \times 70 = 5,600 \\ &5,600 + 420 + 320 + 24 = 6,364 \end{aligned}$$

The area of the garden is 6,364 square inches.

Try This

- 1 Determine the  1,743 $\times$ 9.

 Show your thinking.

answer: _____

Sub-Unit 1 | Summary

In this sub-unit . . .

- We multiplied three- and four-digit numbers by one-digit numbers using partial products strategies.

$$\begin{aligned} &342 \times 4 \\ &300 \times 4 = 1,200 \\ &40 \times 4 = 160 \\ &2 \times 4 = 8 \\ &1,200 + 160 + 8 = 1,368 \end{aligned}$$

- We estimated to determine whether products were reasonable.

$$\begin{aligned} &8 \times 4,973 \\ &\text{estimate: } 8 \times 5,000 = 40,000 \end{aligned}$$

	4,000	900	70	3
8	32,000	7,200	560	24

$$32,000 + 7,200 + 560 + 24 = 39,784$$

39,784 is close to 40,000, so my answer is reasonable.

- We multiplied 2 two-digit numbers.

$$\begin{array}{r} 32 \times 19 \\ \times \quad 19 \\ \hline 1 \ 18 \\ 270 \\ 20 \\ + 300 \\ \hline 608 \end{array}$$
$$\begin{array}{l} 9 \times 2 \\ 9 \times 30 \\ 10 \times 2 \\ 10 \times 30 \end{array}$$

 **Math tip:** Decomposing factors by place value helps you use partial products strategies.

Summary | Lesson 10

Division situations can be written as multiplication equations. The quotient in a division equation is an unknown factor in the related multiplication equation.

dividend		divisor		quotient
112	$\div$	4	=	d
4	$\times$	d	=	112

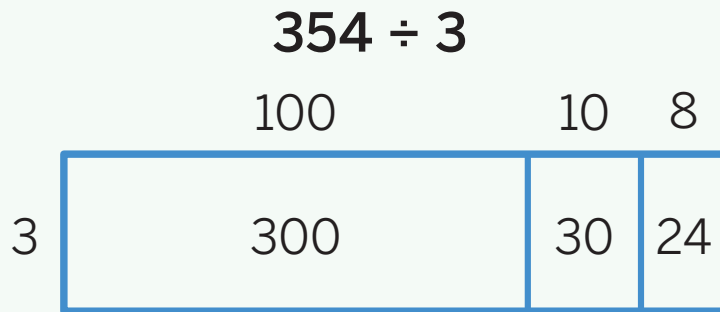
Try This

- 1 Priya harvests 175 tomatoes from her garden. She wants to share them equally with 5 friends. How many tomatoes does each friend get?

 Show or explain your thinking.

answer: _____

When you divide, you can decompose the dividend into parts and divide each part by the divisor. Area diagrams can be used to represent how the dividend is decomposed.



$$100 + 10 + 8 = 118$$
$$354 \div 3 = 118$$

Try This

- 1 The area diagram represents $132 \div 6$. Complete the diagram to determine the quotient.

 **Show your thinking.**



answer: _____

Area diagrams and equations can be used to represent **partial quotients** that result from decomposing the dividend into parts and dividing each part by the divisor. The final quotient is determined by adding the partial quotients.

$$3,235 \div 5$$

$$(3,000 + 200 + 35) \div 5$$

partial quotients

↓ ↓ ↓

600 40 7

5	3,000	200	35
---	-------	-----	----

$3,000 \div 5 = 600$
 $200 \div 5 = 40$
 $35 \div 5 = 7$

}

partial quotients

$$600 + 40 + 7 = 647$$

$$3,235 \div 5 = 647$$

Try This

- Shawn's family is driving to the Grand Canyon, which is 892 miles away. They want to drive the same number of miles each day and get there in 4 days. How many miles should the family drive each day?

Show your thinking.

answer: _____

Dividends can be decomposed into different combinations and numbers of addends to solve division problems using known division or multiplication facts.

$$472 \div 8$$

$$472 = 400 + 72$$

$$400 \div 8 = 50$$

$$72 \div 8 = 9$$

$$50 + 9 = 59$$

$$472 \div 8 = 59$$

$$472 = 400 + 72$$

$$8 \times 50 = 400$$

$$8 \times 9 = 72$$

$$50 + 9 = 59$$

$$472 \div 8 = 59$$

Try This

- 1 Han has 1,484 trading cards. He equally divides his trading cards into 4 bins. How many cards does he put in each bin?



Show your thinking.

answer: _____

Summary | Lesson 14

There are different ways to record partial quotients when dividing multi-digit numbers.

$$645 \div 5$$

$\begin{array}{r} 5 \overline{) 645} \\ - 500 \\ \hline 145 \\ - 100 \\ \hline 45 \\ - 45 \\ \hline 0 \end{array}$	$\left. \begin{array}{l} 5 \times 100 \\ 5 \times 20 \\ 5 \times 9 \end{array} \right\} 129$	$\begin{array}{l} 500 \div 5 = 100 \\ 100 \div 5 = 20 \\ 45 \div 5 = 9 \\ 100 + 20 + 9 = 129 \end{array}$
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Try This

Determine the quotient using any strategy.

 Show your thinking.

1 $424 \div 4$

answer: _____

Estimation can help you check your answers for reasonableness when dividing.

$412 \div 4$
 $400 \div 4 = 100$
So, $412 \div 4$ is about 100.

$412 \div 4$

$4 \overline{) 412}$	
$\underline{- 400}$	4×100
12	
$\underline{- 12}$	4×3
0	

$412 \div 4 = 103$
100 is a reasonable estimate.

Try This

- 1 Use estimation to determine whether Clare's answer is reasonable. Write *yes* or *no*.

Clare has 220 raffle tickets to sell. Each ticket book contains 5 tickets. Clare says she needs to sell 40 books. Is this reasonable?

 Show your thinking.

answer: _____

When creating division story problems that involve determining a quotient, you must have a dividend and a divisor. You can solve the problems using any strategy.

$$428 \div 4$$

Strategies		
$4 \times 100 = 400$ $4 \times 7 = 28$ $100 + 7 = 107$	$400 \div 4 = 100$ $28 \div 4 = 7$ $100 + 7 = 107$	$\begin{array}{r} 4 \overline{)428} \\ -400 \\ \hline 28 \\ -28 \\ \hline 0 \end{array}$ $\left. \begin{array}{l} 4 \times 100 \\ 4 \times 7 \end{array} \right] 107$

Try This

- 1 Create a division story problem that could be solved using $2,840 \div 4$.

Sub-Unit 2 | Summary

In this sub-unit . . .

- We learned that division situations can be written as multiplication equations. The quotient in a division equation is an unknown factor in the related multiplication equation.

dividend		divisor	=	quotient
112	÷	4	=	d
4	×	d	=	112

- We used area diagrams and equations to represent partial quotients.

3,235 ÷ 5
 $(3,000 + 200 + 35) ÷ 5$

partial quotients		
↓	↓	↓
600	40	7

5

3,000	200	35
-------	-----	----

$3,000 ÷ 5 = 600$
 $200 ÷ 5 = 40$
 $35 ÷ 5 = 7$

partial quotients

$600 + 40 + 7 = 647$
 $3,235 ÷ 5 = 647$

 **Math tip:** Decompose the dividend into numbers that are easily divisible by the divisor.

- We created division story problems for others to solve.

Paul had 2,634 inches of string.
 He cut the string into 6-inch
 pieces to make bracelets.
 How many bracelets can he make?

6 $\overline{) 2,634}$			
- 2,400		6×400	
234			
- 180		6×30	
54			
- 54		6×9	
0			
			439
			439 bracelets

Summary | Lesson 17

When dividing numbers, any amount left is called a **remainder**. The problem and the context will help you determine what to do with the remainder.

Maile is packing 294 lei into boxes. Each box can hold up to 4 lei.
How many boxes are needed to pack all the lei?

$$294 \div 4$$

$$280 \div 4 = 70$$

$$12 \div 4 = 3$$

$$280 + 12 = 292$$

$$294 - 292 = 2$$

294 divided by 4 is 73 with a remainder of 2.

Maile needs 74 boxes to fit all the lei.

Try This

- 1 An order has 483 lei that need to be packaged and shipped. If 5 lei can fit in each box, how many boxes are needed to package and ship all the lei?

 Show or explain your thinking.

answer: _____

Summary | Lesson 18

The final answer to a division problem with a remainder depends on how the remainder needs to be interpreted to solve the problem. For some problems, you may need to distribute the remainder.

There are 293 players signed up for a basketball league. The league wants to place 7 players on each team and distribute any leftover players to make some 8-player teams. Determine the number of 7- and 8-player teams.

$$293 \div 7$$

$$293 \div 7 \text{ is } 41 \text{ with a remainder of } 6.$$

$$7 \times 40 = 280$$

$$7 \times 1 = 7$$

$$7 \times 41 = 287$$

41 teams with 6 left
35 teams will have 7 players.
6 teams will have 8 players.

$$293 - 287 = 6$$

Try This

- 1 A basketball league has 178 basketball players. Each team will have 8 players. Any players left will be added to the teams, so some teams will have 9 players. Determine how many teams will have 8 players and how many teams will have 9 players.

 **Show your thinking.**

answer: _____

Summary | Lesson 19

When interpreting story problems that involve equal groups, the context helps you determine what each value represents.

112 students will travel in vans for a field trip. The vans can fit 9 students. What is the fewest number of vans needed?

$$\begin{array}{r} 9 \overline{)112} \\ - 90 \\ \hline 22 \\ - 18 \\ \hline 4 \end{array} \quad \begin{array}{l} 9 \times 10 \\ 9 \times 2 \end{array} \Bigg] 12$$

12 vans would not fit everyone because there would be 4 students left. 13 vans are needed to fit all the students.

Try This

All the fourth-grade teachers and students are receiving a school hat. The school needs 334 hats. Company A sells 24 hats in a package. Company B sells 40 hats in a package.

- 1 What is the *least* number of packages needed from Company A?

 Show your thinking.

answer: _____

Summary | Lesson 20

A variety of strategies can be used when solving real-world problems that require more than 1 step.

Pat's Lei Shop needs to ship 45 boxes of lei. Each box needs 3 cooling packets, and each cooling packet costs \$9. How much will the shop spend on cooling packets?

$$45 \times 3$$

$$40 \times 3 = 120$$

$$5 \times 3 = 15$$

$$120 + 15 = 135$$

$$135 \times 9$$

$$(100 \times 9) + (30 \times 9) + (5 \times 9)$$

$$900 + 270 + 45 = 1,215$$

They need 135 cooling packets.

Pat's Lei Shop will spend \$1,215 on cooling packets.

Try This

- 1 A soccer league orders shirts and shorts for 525 players. Each shirt costs \$5, and each pair of shorts costs \$3. If each player receives 1 shirt and 1 pair of shorts, what is the total cost of the shirts and shorts?

 **Show your thinking.**

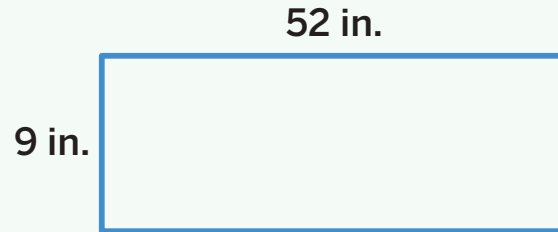
answer: _____

Summary | Lesson 21

Formulas for area and perimeter can be used to solve real-world problems.

Maile used a piece of paper that is 52 inches by 9 inches to create a banner. What is the area of the banner?

Maile wants to add ribbon as a border to the banner. What length of ribbon would she need?



$$\begin{aligned}\text{Area} &= \ell \times w \\ 9 \times 52 &= 468 \text{ sq. in.}\end{aligned}$$

$$\begin{aligned}\text{Perimeter} &= 2 \times (\ell + w) \\ 9 \times (9 + 52) \\ 9 \times 61 &= 122 \text{ in.}\end{aligned}$$

Try This

- 1 Jada wants to build a wood fence around her rectangular garden. The garden measures 3 yards wide and 20 feet long. How much wood fencing, in feet, will she need?

 Show your thinking.

answer: _____

Summary | Lesson 22

Multi-step problems can be solved and represented in different ways.

Movie tickets are \$9 each. A movie theater sold the same number of tickets 2 days in a row. If the theater made a total of \$9,414 from ticket sales, how many tickets did they sell each day?

First way	Second way	Third way
$9,414 \div 2 = 4,707$ $4,707 \div 9 = 523$	$9,414 \div 9 = 1,046$ $1,046 \div 2 = 523$	$(9,414 \div 2) \div 9 = 523$

523 tickets were sold each day.

Try This

Solve the problem using any strategy.

- 1 Clare and her sister are calculating the number of beads they need to make 92 bracelets and 68 necklaces for a craft show. They need 6 beads for each bracelet and 14 beads for each necklace. How many beads do they need in all?

 Show your thinking.

answer: _____

Sub-Unit 3 | Summary

In this sub-unit . . .

- We learned that when dividing numbers, any amount left is called a remainder.

$$\begin{array}{r} 6 \overline{) 378} \\ - 200 \\ \hline 178 \\ - 160 \\ \hline 18 \\ - 16 \\ \hline 2 \end{array} \quad \begin{array}{l} 4 \times 50 \\ 4 \times 40 \\ 4 \times 4 \end{array} \quad \left. \begin{array}{l} \\ \\ \end{array} \right] \begin{array}{l} 94 \\ \uparrow \\ \text{quotient} \end{array}$$

$\uparrow$
remainder

 **Math tip:** The remainder should be less than the divisor. Otherwise, you can make more equal groups.

- We used the context of problems to determine what to do with the remainder.

Maile is packing 294 lei into boxes.
Each box can hold up to 4 lei.
How many boxes are needed to
pack all the lei?

$$\begin{array}{l} 294 \div 4 \\ 280 \div 4 = 70 \\ 12 \div 4 = 3 \\ 280 + 12 = 292 \\ 294 - 292 = 2 \\ 294 \text{ divided by } 4 \text{ is } 73 \text{ with} \\ \text{a remainder of } 2. \\ \text{Maile needs } 74 \text{ boxes to fit all the lei.} \end{array}$$

- We solved problems that required more than 1 step.

Pat's Lei Shop needs to ship 45 boxes of lei. Each box needs 3 cooling packets, and each cooling packet costs \$9. How much will the shop spend on cooling packets?

$$\begin{array}{l} 45 \times 3 \\ 40 \times 3 = 120 \\ 5 \times 3 = 15 \\ 120 + 15 = 135 \\ \text{They need } 135 \text{ cooling packets.} \end{array}$$

$$\begin{array}{l} 135 \times 9 \\ (100 \times 9) + (30 \times 9) + (5 \times 9) \\ 900 + 270 + 45 = 1,215 \\ \text{Pat's Lei Shop will spend } \$1,215 \\ \text{on cooling packets.} \end{array}$$

Try This | Answer Key

Lesson 2

1 A, B, D, E

Lesson 3

1 C

Lesson 4

1 Sample response shown.
 $700 \times 3 = 2,100$
answer: 2,100

Lesson 5

1 Sample work shown.

$$\begin{array}{r} 365 \times 7 \\ 300 \times 7 = 2,100 \\ 60 \times 7 = 420 \\ 5 \times 7 = 35 \\ 2,100 + 420 + 35 = 2,555 \end{array}$$

answer: 2,555

Lesson 6

1 Sample explanation shown.
Shawn. First, I determined the area of Jada's garden: $15 \times 25 = 375$, so 375 square feet. Then I determined the area of Shawn's garden: $18 \times 23 = 414$, so 414 square feet. $414 > 375$

Lesson 7

1 Sample work shown.

	30	4	
10	$10 \times 30 = 300$	$10 \times 4 = 40$	300 40
8	$8 \times 30 = 240$	$4 \times 8 = 32$	240 + 32 612

answer: 612

Try This | Answer Key

Lesson 8

1 Sample work shown.

	60	8
40	$40 \times 60 = 2,400$	$40 \times 8 = 320$
5	$5 \times 60 = 300$	$5 \times 8 = 40$

answer: 3,060

Lesson 9

1 Sample work shown.

$$\begin{aligned} &1,743 \times 9 \\ &1,000 \times 9 = 9,000 \\ &700 \times 9 = 6,300 \\ &40 \times 9 = 360 \\ &3 \times 9 = 27 \\ &9,000 + 6,300 + 360 + 27 = 15,687 \end{aligned}$$

answer: 15,687

Lesson 10

1 Sample work shown.

	20	14	1
5	100	70	5

$$20 + 14 + 1 = 35$$

answer: 35 tomatoes

Lesson 11

1 Sample work shown.

	10	10	2
6	60	60	12

$$10 + 10 + 2 = 22$$

answer: 22

Try This | Answer Key

Lesson 12

1 Sample work shown.

$$800 \div 4 = 200$$

$$92 \div 4 = 23$$

answer: 223 miles

Lesson 13

1 Sample work shown.

$$1,000 \div 4 = 250$$

$$400 \div 4 = 100$$

$$84 \div 4 = 21$$

$$250 + 100 + 21 = 371$$

answer: 371 cards

Lesson 14

1 Sample work shown.

$$\begin{array}{r} 4 \overline{) 424} \\ - 400 \quad 4 \times 100 \\ \hline 24 \\ - 24 \quad 4 \times 6 \\ \hline 0 \end{array} \quad \left. \vphantom{\begin{array}{r} 4 \overline{) 424} \\ - 400 \\ \hline 24 \\ - 24 \\ \hline 0 \end{array}} \right] 106$$

answer: 106

Lesson 15

1 Sample work shown.

$$220 \rightarrow 200$$

$$200 \div 5 = 40$$

answer: yes

Lesson 16

1 Sample response shown.

A preschool teacher ordered 2,840 blocks.

She divided them equally into 4 bins. How many blocks did she put in each bin?

Lesson 17

1 Sample work shown.

$$\begin{array}{r} 5 \overline{)483} \\ - 400 \\ \hline 83 \\ - 80 \\ \hline 3 \end{array} \left. \begin{array}{l} 5 \times 80 \\ 5 \times 16 \end{array} \right] 96$$

answer: 97 boxes

Lesson 18

1 Sample work shown.

$$178 \div 8$$

$$160 \div 8 = 20$$

$$16 \div 8 = 2$$

$$20 + 2 = 22$$

22 teams, 2 players left

answer: 20 teams with 8, 2 teams with 9

$$160 + 16 = 176$$

$$178 - 176 = 2$$

Lesson 19

1 Sample work shown.

$$24 \times 10 = 240$$

$$24 \times 12 = 240 + 48 = 288$$

$$24 \times 14 = 288 + 48 = 336$$

14 packages would have 336 hats, so all 334 people would get a hat.

answer: 14 packages

Lesson 20

1 Sample work shown.

$$5 \times 525$$

$$\begin{array}{r} 12 \\ 525 \\ \times 5 \\ \hline 2,625 \end{array}$$

$$3 \times 525$$

$$\begin{array}{r} 1 \\ 525 \\ \times 3 \\ \hline 1,575 \end{array}$$

$$2,625 + 1,575$$

$$\begin{array}{r} 111 \\ 2,625 \\ + 1,575 \\ \hline 4,200 \end{array}$$

answer: \$4,200

Try This | Answer Key

Lesson 21

1 Sample work shown.

$$1 \text{ yard} = 3 \text{ feet}$$

$$3 \times 3 = 9 \text{ or } 9 \text{ feet}$$

$$(20 \times 2) + (9 \times 2)$$

$$40 + 18 = 58$$

answer: 58 feet

Lesson 22

1 Sample work shown.

	90	2
6	540	12

$$540 + 12 = 552$$

	10	4
60	600	240
8	80	32

$$600 + 240 + 80 + 32 = 952$$

$$552 + 952 = 1,504$$

answer: 1,504 beads