3

Technology companies, like those located in California's Silicon Valley, design and build digital products. How many images can a 32 MB memory stick for a digital camera hold? You will find out in Lesson 3-3.

4

One man balanced 75 drinking glasses on his chin. What was the capacity of the drinking glasses he balanced? You will find out in Lesson 3-4.

Vocabulary

Choose the best term from the box.

- equation
- product
- factors
- round

1. A(n) __?__ is another word for a number sentence.

2. One way to estimate a number is to __?__ the number.

3. A(n) __?__ is the answer you get when you multiply.

4. In the equation $9 \times 5 = 45$, 9 and 5 are both __?__.

Multiplication Facts

Find each product.

5. 3×9 6. 5×6 7. 4×8

8. 6×9 9. 7×4 10. 9×8

11. 7×6 12. 8×8 13. 7×9

Rounding

Round each number to the nearest hundred.

14. 864   15. 651   16. 348

17. 985   18. 451   19. 749

Multiplication Properties

Writing to Explain Write an answer to the question.

20. How do you know that $(3 \times 6) \times 4 = 3 \times (6 \times 4)$?

AF 1.3, Grade 6
Apply algebraic order of operations and the commutative, associative, and distributive properties to evaluate expressions; and justify each step in the process.

Multiplication Properties

What are the properties of multiplication?

Do 2 groups of 5 beach balls equal 5 groups of 2 beach balls?

Factors are numbers that are multiplied to get a product.

Commutative Property of Multiplication

The order of factors can be changed.
The product stays the same.

$$2 \times 5 = 5 \times 2$$

Guided Practice*

Do you know HOW?

In **1** through **5**, write the multiplication property used in each equation.

1. $65 \times 1 = 65$

2. $45 \times 6 = 6 \times 45$

3. $33 \times 0 = 0$

4. $11 \times 9 = 9 \times 11$

5. $(6 \times 20) \times 5 = 6 \times (20 \times 5)$

Do you UNDERSTAND?

6. Using equations, give an example for each property of multiplication.

7. In the following equations, what number should replace each ▮? Which property of multiplication is used?

a $40 \times 8 = \text{▮} \times 40$

b $1,037 \times \text{▮} = 1,037$

Independent Practice

In **8** through **19**, write the multiplication property used in each equation.

8. $537 \times 1 = 537$

9. $24 \times 32 = 32 \times 24$

10. $400 \times 0 = 0$

11. $73 \times 14 = 14 \times 73$

12. $5 \times (40 \times 9) = (5 \times 40) \times 9$

13. $1 \times 111 = 111$

14. $0 \times 1,247 = 0$

15. $8 \times (4 \times 3) = (8 \times 4) \times 3$

16. $(9 \times 3) \times 5 = 9 \times (3 \times 5)$

17. $1 \times 90 = 90 \times 1$

18. $76 \times 1 = 76$

19. $0 \times 563 = 0$

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*For another example, see Set A on page 74.

Associative Property of Multiplication	Identity Property of Multiplication	Zero Property of Multiplication
You can change the grouping of the factors. The product stays the same.	When you multiply any number by 1, the product is that number.	When you multiply any number by 0, the product is 0.
$(2 \times 5) \times 3 = 2 \times (5 \times 3)$	$5 \times 1 = 5$	$5 \times 0 = 0$

Reasoning In **20** through **25**, use the multiplication properties to determine the number that belongs in each box.

20. $1,037 \times \boxed{} = 1,037$

21. $5 \times (20 \times 9) = (5 \times 20) \times \boxed{}$

22. $(635 \times 47) \times \boxed{} = 0$

23. $8 \times (\boxed{} \times 4) = (8 \times 5) \times 4$

24. $75 \times \boxed{} = 42 \times 75$

25. $(9 \times 6) \times 4 = 9 \times (\boxed{} \times 4)$

Problem Solving

26. Writing to Explain Haley said that she would always know her 0 and 1 multiplication facts. Explain why Haley would say this.

27. Writing to Explain How can one of the multiplication properties help you evaluate $(77 \times 25) \times 4$?

28. Last month 48,097 people visited the zoo. The number 48,097 is how many more than 25,000?

    A 2,079   **C** 23,097

    B 12,097   **D** 320,079

29. Think About the Process Naomi ordered 2 bottles of water for $1.00 each and 1 turkey sandwich for $3.00. Which expression would you use to find how much Naomi paid?

    A $(2 \times \$1) \times \$3$

    B $2 \times (1 \times \$3)$

    C $(2 + \$1) + \$2$

    D $(2 \times \$1) + (1 \times \$3)$

30. Compare. Write $>$, $<$, or $=$ for each $\bigcirc$.

    a 34,304 $\bigcirc$ 43,403

    b 5.70 $\bigcirc$ 5.7

    c 21,978 $\bigcirc$ 21,789

31. Three hundred fifty 10-year olds registered for a city-wide bowling tournament. If 205 participants are boys, how many are girls?

32. Critical Thinking Think of two numbers that will round to 14,000.

Lesson
3-2

NS 1.1 Estimate, round, and manipulate very large (e.g., millions) and very small (e.g., thousandths) numbers.

Estimating Products

How can you estimate products?

A store needs to take in at least $15,000 in sales per month to make a profit. If the store is open every day in March and takes in an average of $525 per day, will the store make a profit in March?

Does the store make $15,000?

Another Example **What is another way to estimate products?**

Estimate 24×39.

You can also use compatible numbers to estimate products.

It is easy to find 25×40, since 25 and 40 are compatible numbers. Remember that $25 \times 4 = 100$. So, $25 \times 40 = 1,000$, and 1,000 is a good estimate for 24×39.

Both numbers used to estimate were greater than the actual numbers. So, 1,000 is an overestimate.

Guided Practice*

Do you know HOW?

In **1** and **2**, estimate by using rounding. Tell if your estimate is an overestimate or underestimate.

1. 58×6

2. 733×21

In **3** and **4**, estimate by using compatible numbers. Tell if your estimate is an overestimate or underestimate.

3. $43 \times 27 \times 4$

4. 38×69

Do you UNDERSTAND?

5. **Writing to Explain** Susan used rounding to estimate 243×4 and found 200×4. Jeremy used compatible numbers and found 250×4. The actual product is 972. Whose method gives an estimate closer to the actual product?

6. **Reasonableness** In the example above, why is it better to adjust $525 to $500 rather than leave the number at $525?

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*For another example, see Set B on page 74.

You can use rounding to estimate products.

$525 rounds to **$500**.

31 rounds to **30**.

Find 30 × 500.

Think I know that 3 × 5 = 15.

30 × **500** = 15,**000**

Both numbers used to estimate were less than the actual numbers, so 15,000 is an <mark>underestimate</mark>. The store will actually take in more than $15,000.

So, the store will make a profit in March.

Independent Practice

In **7** through **18**, estimate each product.

7. 75 × 28   **8.** 3 × 118   **9.** 39 × 58   **10.** 97 × 15

11. 513 × 19   **12.** 64 × 55   **13.** 286 × 9   **14.** 11 × 83

15. 10 × 66   **16.** 26 × 29 × 41   **17.** 18 × 999,999   **18.** 3 × 1,029,000

Problem Solving

19. Reasoning Estimate 53 × 375. Is the estimated product closer to 15,000 or 20,000?

20. Kilauea has been active since 1983. About how many cubic meters of lava is discharged in one minute?

21. Writing to Explain Samuel needs to estimate the product of 95 × 23 × 4. Explain two different methods Samuel could use to estimate.

22. Give two factors whose estimated product is about 800.

23. Jacque uses 11 sheets of notebook paper each day at school. If he has a package of 150 sheets, will that be enough paper for him to use for 3 weeks at school? Use an estimate to find out.

Lava is discharged from the volcano at about 7 cubic meters per second.

Multiplying by 1-Digit Numbers

How do you multiply by 1-digit numbers?

How many beads are in 7 containers?

Choose an Operation
Multiply to join equal groups.

36 Beads

Another Example **How do you multiply a 1-digit number by a 4-digit number?**

A sports arena has 9 sections with 1,237 seats in each section. What is the total number of seats in the arena?

A 11,034   **B** 11,100   **C** 11,121   **D** 11,133

Choose an Operation Multiply to join equal groups.

Find $1,237 \times 9$.

Step 1	**Step 2**	**Step 3**
Multiply the ones, and regroup if necessary.	Multiply the tens. Add any extra tens. Regroup if necessary.	Multiply the hundreds and thousands. Add any extra hundreds and thousands. Regroup if necessary.

Step 1

$$\begin{array}{r} \overset{6}{1,23\mathbf{7}} \\ \times \quad \mathbf{9} \\ \hline \mathbf{3} \end{array}$$

9×7 ones = 63 ones
Regroup 63 ones as 6 tens 3 ones.

Step 2

$$\begin{array}{r} \overset{36}{1,2\mathbf{3}7} \\ \times \quad \mathbf{9} \\ \hline \mathbf{33} \end{array}$$

$9 \times 3 = 27$ tens
27 tens + 6 tens = 33 tens
Regroup as 3 hundreds 3 tens

Step 3

$$\begin{array}{r} \overset{2\ 36}{1,\mathbf{2}37} \\ \times \quad \mathbf{9} \\ \hline \mathbf{11,133} \end{array}$$

$9 \times 2 = 18$ hundreds
18 hundreds + 3 hundreds = 21 hundreds
Regroup as 2 thousands 1 hundred.
$9 \times 1 = 9$ thousands
9 thousands + 2 thousands = 11 thousands

The arena can hold 11,133 people. The correct choice is D.

Remember how to multiply using partial products.

$$36$$
$$\times\ \ \ 7$$
$$\overline{\hphantom{0}42} \longleftarrow \ \ 7 \times 6$$
$$+\ 210 \longleftarrow \ \ 7 \times 30$$
$$\overline{\hphantom{0}252}$$

The partial products are 42 and 210. You add them to find the product.

Step 1 Multiply the ones. Regroup if necessary.

$$3\overset{4}{6}$$
$$\times\ \ \ 7$$
$$\overline{\hphantom{00}2}$$

7 × 6 ones = 42 ones
Regroup 42 ones as 4 tens 2 ones.

Step 2 Multiply the tens. Add any extra tens. Regroup if necessary.

$$3\overset{4}{6}$$
$$\times\ \ \ 7$$
$$\overline{252}$$

7 × 3 tens = 21 tens
21 tens + 4 tens = 25 tens
Regroup 25 tens as 2 hundreds 5 tens.

There are 252 beads in 7 containers.

Guided Practice*

Do you know HOW?

In **1** and **2**, follow the steps from above to multiply.

1. 63
$\times\ \ 8$

2. 274
$\times\ \ \ \ 3$

Do you UNDERSTAND?

3. Writing to Explain In step 2 of Another Example, why is it necessary to regroup the 33 tens?

4. In the example at the top, how many beads would be in 9 containers?

Independent Practice

In **7** through **29**, find each product. Estimate to check that your answer is reasonable.

7. 62
$\times\ \ 7$

8. 1,247
$\times\ \ \ \ \ \ \ 2$

9. 921
$\times\ \ \ \ 8$

10. 438
$\times\ \ \ \ 3$

11. 2,979
$\times\ \ \ \ \ \ \ 6$

12. 73
$\times\ \ 9$

13. 18
$\times\ \ 5$

14. 38
$\times\ \ 8$

15. 1,218
$\times\ \ \ \ \ \ 7$

16. 55
$\times\ \ 4$

17. 264
$\times\ \ \ 4$

18. 873
$\times\ \ \ 6$

19. 237
$\times\ \ \ 6$

20. 9,843
$\times\ \ \ \ \ \ 4$

21. 627
$\times\ \ \ 3$

22. 795 × 5　　　　**23.** 227 × 3　　　　**24.** 4,596 × 4　　　　**25.** 25 × 9

26. 6,330 × 9　　　　**27.** 41 × 8　　　　**28.** 5,532 × 6　　　　**29.** 69 × 7

Problem Solving

For **30** and **31**, use the table below.

Paper towels needed to be collected for a school science project.

Mr. Green's Class	
Day	**Number of Paper Towel Rolls**
Monday	8
Tuesday	6
Wednesday	5
Thursday	3
Friday	4

30. Ms. Martinez's class collected three times as many paper towel rolls as Mr. Green's class. What is the total number of paper towel rolls collected by the two classes?

31. Order the days of the week from least paper towel rolls collected to greatest paper towels collected.

32. Use partial products to solve: 89 × 6.

33. Writing to Explain Why is it important to regroup correctly?

34. **Think About the Process** A popular Mexican restaurant has 48 tables. Each table has 3 different types of salsa. In one day, all of the tables are used for 9 different sets of customers. Which of the following would be best to estimate how many containers of salsa will be needed for all the tables in one day?

　A 50 × 9　　　　**C** 50 × 3 × 10

　B 48 × 3 × 9　　　**D** 40 × 5 × 5

35. A group of 24 students and 2 teachers went to a school fair. Each student spent $8 on tickets and $3 on snacks. What information is not needed to find out how much the 24 students and 2 teachers spent for tickets?

　A The number of teachers

　B The price of snacks

　C The price of tickets

　D The number of students

36. Hummingbirds eat simple syrup, which is a sugar and water solution. To make simple syrup, you need 4 parts sugar and 1 part water. If you have 12 cups of water, how many cups of sugar do you need?

37. A memory stick can be used to store images from a digital camera. The first memory stick was available in 1998. A 32 MB memory stick can hold up to 491 images. How many images can 7 memory sticks hold?

38. Writing to Explain Paul needs to estimate the product of 87 × 23 × 4. Explain two different estimation strategies he can use.

Mixed Problem Solving

Newbery Medal Winners for Children's Literature			
Author	**Title of Book**	**Year**	**Pages**
Jerry Spinelli (1941–Present)	*Maniac Magee*	1991	184
Beverly Cleary (1916–Present)	*Dear Mr. Henshaw*	1984	160
Nancy Willard (1936–Present)	*A Visit to William Blake's Inn*	1982	48
E.L. Konigsburg (1930–Present)	*From the Mixed-Up Files of Mrs. Basil E. Frankweiler*	1968	176

For **1** through **6**, use the table above.

1. Which writer has lived the longest?

2. The first Newbery Medal was awarded in 1923. How many years after this first award did Jerry Spinelli receive his award?

3. How old was E.L. Konigsburg when she published *From the Mixed-Up Files of Mrs. Basil E. Frankweiler*?

4. What is the difference in the number of pages between the shortest and longest books in the table?

5. How much older is the author of *Dear Mr. Henshaw* than the author of *A Visit to William Blake's Inn*?

6. **Strategy Focus** Solve using the strategy Draw a Picture and Write an Equation.

   In the first quarter of the year, Paul has to write two book reports. He chose to read *Maniac Magee* and *Dear Mr. Henshaw*. How many pages will Paul have to read in all for his book reports? Let p = the number of pages Paul has to read.
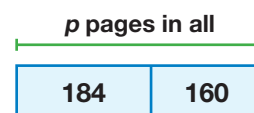
p pages in all	
184	160

NS 1.0 Students compute with very large and very small numbers, positive integers, decimals, and fractions and understand the relationship between decimals, fractions, and percents. They understand the relative magnitude of numbers. Also **NS 3.3** ⚬━━ , Grade 4

Multiplying by 2-Digit Numbers

How do you multiply by 2-digit numbers?

Sammy's Car Wash had 38 full-service car washes in one day. How much money did Sammy's Car Wash make in one day from full-service car washes?

Choose an Operation
Multiply to join equal groups.

CAR WASH

SERVICE	COST
EXTERIOR ONLY	$8^{00}
FULL SERVICE	$12^{00}
VACUUM	$5^{00}

Other Examples

In Lesson 3-3. you learned how to multiply by 1-digit numbers. In this lesson you multiply by 2-digit numbers and have partial products to add.

2-digit by 2-digit

$$\begin{array}{r} 57 \\ \times\ 43 \\ \hline 171 \\ 2\,280 \\ \hline 2{,}451 \end{array}$$

3-digit by 2-digit

$$\begin{array}{r} 982 \\ \times\ 37 \\ \hline 6874 \\ 29\,460 \\ \hline 36{,}334 \end{array}$$

4-digit by 2-digit

Step 1

Multiply the ones. Regroup.

$$\begin{array}{r} 2538 \\ \times\ 31 \\ \hline 2538 \end{array}$$

Step 2

Multiply the tens. Use one zero as a placeholder in your second partial product. Regroup.

$$\begin{array}{r} {}^{1\ 1\ 2} \\ 2538 \\ \times\ 31 \\ \hline 2538 \\ 76140 \end{array}$$

Step 3

Add the partial products.

$$\begin{array}{r} 2538 \\ \times\ 31 \\ \hline 2538 \\ 76140 \\ \hline 78{,}678 \end{array}$$

Explain It

1. Explain why the second partial product always has a zero in the ones place.

2. **Reasonableness** How can you use compatible numbers to determine if 78,678 is reasonable?

Step 1

Multiply the ones. Regroup.

$$\begin{array}{r} 1 \\ 38 \\ \times 12 \\ \hline 76 \end{array}$$

2 × 8 ones = 16 ones
Regroup 16 ones as 1 ten and 6 ones.

2 × 3 tens = 6 tens
6 tens + 1 ten = 7 tens

Step 2

Multiply the tens. Regroup.

$$\begin{array}{r} 1 \\ 38 \\ \times 12 \\ \hline 76 \\ 380 \end{array}$$

10 × 8 ones = 80 ones or 8 tens

10 × 3 tens = 30 tens or 3 hundreds

Step 3

Add the <mark>partial products</mark>.

$$\begin{array}{r} 1 \\ 38 \\ \times 12 \\ \hline 76 \\ + 380 \\ \hline 456 \end{array}$$

76 ← partial product
380 ← partial product

Sammy's Car Wash made $456.

Guided Practice*

Do you know HOW?

In **1** through **6**, find each product. Find each product. Estimate to check that your answer is reasonable.

1. $72 \times 16 = $ ▢

2. $843 \times 21 = $ ▢

3. $253 \times 13 = $ ▢

4. $3,419 \times 62 = $ ▢

5. $38 \times 95 = $ ▢

6. $75 \times 5,614 = $ ▢

Do you UNDERSTAND?

7. **Reasonableness** How can you use estimation to decide if the $456 Sammy's Car Wash made is reasonable?

8. In the example at the top, what would the car wash make if it charged $15 for each full-service car wash?

Independent Practice

In **9** through **28**, find the product. Estimate to check that your answer is reasonable.

9.
$$\begin{array}{r} 44 \\ \times\ 23 \\ \hline \end{array}$$

10.
$$\begin{array}{r} 115 \\ \times\ 89 \\ \hline \end{array}$$

11.
$$\begin{array}{r} 67 \\ \times\ 57 \\ \hline \end{array}$$

12.
$$\begin{array}{r} 984 \\ \times\ 45 \\ \hline \end{array}$$

13.
$$\begin{array}{r} 56 \\ \times\ 37 \\ \hline \end{array}$$

14.
$$\begin{array}{r} 23 \\ \times\ 76 \\ \hline \end{array}$$

15.
$$\begin{array}{r} 127 \\ \times\ 45 \\ \hline \end{array}$$

16.
$$\begin{array}{r} 679 \\ \times\ 21 \\ \hline \end{array}$$

17. 17×12

18. 263×18

19. $3,519 \times 29$

20. $7,227 \times 51$

21. 19×15

22. 838×47

23. $5,215 \times 36$

24. 77×18

25. 23×16

26. 442×11

27. 33×42

28. $1,236 \times 12$

29. The principal of your school is buying 3 computers at $900 each. She can pay $98 per month instead of paying the full price. Will she have paid for them by the end of 12 months?

30. The 2001 record for balancing drinking glasses on one's chin was 75 glasses. If the capacity of each glass was 20 fluid ounces, how many total fluid ounces could all the glasses contain?

31. How much would 85 barrels of oil have cost in 1984?

32. How much more would 65 barrels of oil have cost in 2004 than in 1974?

33. Writing to Explain How can finding the answer to 5×700 help you find the answer to 5×789?

World Oil Prices	
Year	**Price per Barrel**
1974	$9
1984	$29
1994	$16
2004	$38

34. The label on Bonnie's jigsaw puzzle states that the puzzle had more than 1,000 pieces. After Bonnie and her friend put the puzzle together, they counted 44 pieces across the top and 28 pieces down the side. Estimate to determine if the label was correct.

35. There are 21 classrooms at Pine Elementary School. The classes range between 27 and 33 students. Which is the best estimate of the total number of students in the school?

A 300   **C** 500

B 400   **D** 600

36. Which of the following is 8,004,231,900?

A eight billion, four hundred twenty three million, nine hundred

B eight billion, four million, two hundred thirty-one thousand, nine hundred

C eight million, two hundred thirty-one thousand, nine hundred four

D eight million, four thousand, two hundred thirty-one

37. A teacher asks 11 students to help set up chairs for an assembly. Each student can set up 3 chairs per minute. If the students work for 15 minutes, will there be enough chairs to seat 500 people at the assembly? Explain.

38. The Explorer Hiking Club has 64 members. How much will it cost for all members to buy new Terrain backpacks?

39. The club also needs to buy 16 dome tents and 16 propane stoves. Will they spend more or less on these items than on the backpacks? How much more or less?

Camping Gear Prices	
Gear	**Price**
Dome Tent	$99
Propane Stove	$28
Terrain Backpack	$87

Find the product. Estimate to check if the answer is reasonable.

1. 58
$\times$ 4

2. 355
$\times$ 7

3. 6,044
$\times$ 6

4. 5,137
$\times$ 3

5. 236
$\times$ 17

6. 23
$\times$ 25

7. 117
$\times$ 33

8. 65
$\times$ 29

9. 45×12

10. $1,001 \times 25$

11. $8 \times 3,030$

12. $6 \times 3,373$

Find the sum. Estimate to check if the answer is reasonable.

13. 76,095
+ 3,950

14. 9,713
+ 9,328

15. 888
+ 726

16. 7,566
+ 8,092

17. 27,444
+ 9,507

Error Search Find each answer that is not correct.
Write it correctly and explain the error.

18. 703
$\times$ 88
11,248

19. 348
$\times$ 17
5,916

20. 202
$\times$ 15
1,010

21. 19
$\times$ 18
344

22. 2,456
$\times$ 73
179,288

Number Sense

Estimating and Reasoning Write whether each statement is true or false. Explain your reasoning.

23. The product of 7 and 6,943 is closer to 42,000 than 49,000.

24. The difference of 15.9 and 4.2 is closer to 11 than 12.

25. The sum of 33,345 and 60,172 is less than 93,000.

26. The product of 43 and 5,116 is greater than 200,000.

27. The sum of $3.98 + 4.62$ is 0.02 less than 8.62.

28. The product of 9 and 48 is 18 less than 450.

Estimating and Multiplying with Greater Numbers

NS 1.0 Students compute with very large and very small numbers, positive integers, decimals, and fractions and understand the relationship between decimals, fractions, and percents. They understand the relative magnitudes of numbers. Also **MR 2.1**
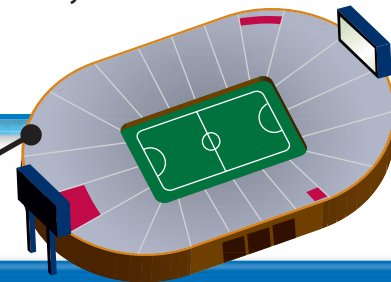
How do you estimate the product of greater numbers and then find the actual product?

A team played 145 home games. They sold about the same number of tickets for each game. How many tickets did they sell in all?

Choose the Operation Find $9,212 \times 145$.

Estimate: $9,000 \times 100 = 900,000$

9,212 tickets sold last night

Guided Practice*

Do you know HOW?

In **1** and **2**, estimate each product.

1. $7,893 \times 456$ **2.** $5,083 \times 923$

In **3** and **4**, multiply to find the product. Check for reasonableness.

3. $\begin{array}{r} 4,816 \\ \times\ \ \ 253 \end{array}$ **4.** $\begin{array}{r} 2,152 \\ \times\ \ \ 148 \end{array}$

Do you UNDERSTAND?

5. In the example above, to what place were the factors rounded?

6. Writing to Explain In the example above, would using the compatible numbers 10,000 and 100 give a closer estimate to the product? Explain.

Independent Practice

In **7** through **10** estimate each product.

7. $\begin{array}{r} 5,691 \\ \times\ \ \ 451 \end{array}$ **8.** $\begin{array}{r} 155 \\ \times\ 989 \end{array}$ **9.** $\begin{array}{r} 4,449 \\ \times\ \ \ 723 \end{array}$ **10.** $\begin{array}{r} 2,505 \\ \times\ \ \ 118 \end{array}$

In **11** through **19**, multiply to find the product. Check for reasonableness.

11. $\begin{array}{r} 1,862 \\ \times\ \ \ 561 \end{array}$ **12.** $\begin{array}{r} 4,726 \\ \times\ \ \ 907 \end{array}$ **13.** $\begin{array}{r} 7,152 \\ \times\ \ \ 283 \end{array}$

14. $\begin{array}{r} 9,814 \\ \times\ \ \ 509 \end{array}$ **15.** $\begin{array}{r} 6,479 \\ \times\ \ \ 362 \end{array}$ **16.** $\begin{array}{r} 1,279 \\ \times\ \ \ 445 \end{array}$

17. $\begin{array}{r} 8,922 \\ \times\ \ \ 290 \end{array}$ **18.** $\begin{array}{r} 2,311 \\ \times\ \ \ 875 \end{array}$ **19.** $\begin{array}{r} 3,271 \\ \times\ \ \ 231 \end{array}$

*For another example, see Set D on page 75.

Step 1	Step 2	Step 3	Step 4

Step 1
Multiply the ones. Regroup.

$$\begin{array}{r} {}^{1}\;{}^{1}\;\; \\ 9212 \\ \times\quad 145 \\ \hline 46060 \end{array}$$

Step 2
Multiply the tens. Regroup.

$$\begin{array}{r} 9212 \\ \times\quad 145 \\ \hline 46060 \\ 368480 \end{array}$$

Step 3
Multiply the hundreds. Regroup.

$$\begin{array}{r} 9212 \\ \times\quad 145 \\ \hline 46060 \\ 368480 \\ 921200 \end{array}$$

Step 4
Add the partial products.

$$\begin{array}{r} {}^{1}\;{}^{1}\;\; \\ 9212 \\ \times\quad 145 \\ \hline 46060 \\ 368480 \\ +\;\;921200 \\ \hline 1{,}335{,}740 \end{array}$$

Check: The answer is reasonable because it is close to the estimate.

The team sold 1,335,740 tickets for all home games.

Problem Solving

20. An electronics store pays $2,876 for each 42-inch LCD TV they sell. If the store sells 32 of these TVs, how much will the store have made? Use the chart at the right.

Data

Sale	
36 inch LCD TV	$2,299
42 inch LCD TV	$3,256
Stereo System	$869

21. Geometry If each side of a hexagon is 32 cm, what is the perimeter of the hexagon?

   A 128 cm

   B 160 cm

   C 192 cm

   D 1,024 cm

22. Estimation The fifth-grade class at Monticello Elementary School sold more bags of popcorn than any other class. They ordered 17 cases of popcorn. Each case had 242 bags. About how many bags of popcorn did the class sell?

   A 3,000   **C** 5,500

   B 4,000   **D** 6,000

23. Think About the Process A dog's heart rate is about 100 beats per minute. A rabbit's is about 212 beats per minute. Which expression shows how to find the total number of heartbeats in about 1 hour for a dog and a rabbit?

   A $(100 \times 1) = (212 \times 1)$

   B $60 \times 100 \times 212$

   C $(60 \times 100) + (60 \times 212)$

   D $(212 \times 100) + 60$

24. Estimation The length of the Nile River in Africa is about 14 times the length of Lake Michigan. About how many miles long is the Nile River?

Lake Michigan — 307 mi.

Lesson

3-6

NS 1.3 Understand and compute positive integer powers of non-negative integers; compute examples as repeated multiplication.
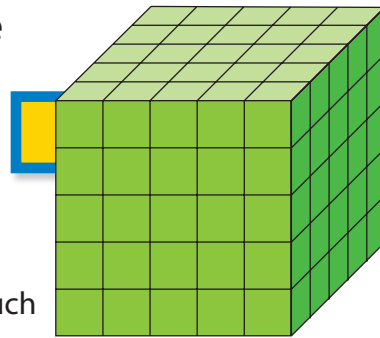
Exponents

How can you use exponents to write large numbers?

A box of cubes has 5 layers. Each layer has 5 rows, with 5 cubes in each row.

There are $5 \times 5 \times 5$ cubes in the box.

You can use exponential notation to represent repeated multiplication of the *same* number such as $5 \times 5 \times 5$.

Other Examples

Standard form
Write 2^5 in standard form.

$2^5 = 2 \times 2 \times 2 \times 2 \times 2$
$\quad = 32$

Expanded form
Write 10^4 in expanded form.

$10^4 = 10 \times 10 \times 10 \times 10$

Exponential notation
Write $4 \times 4 \times 4$ in exponential notation.

$4 \times 4 \times 4 = 4^3$

An exponent is also called a power. You can read 4^6 as "4 to the sixth power". The second and third powers have special names. Read 3^2 as "3 to the second power," or 3 squared. Read 6^3 as "6 to the third power," or 6 cubed.

Guided Practice*

Do you know HOW?

1. Write 3^5 in expanded form.

2. Write 2^4 in standard form.

3. Write $7 \times 7 \times 7 \times 7 \times 7$ using exponential notation.

4. Write 5^4 in expanded form and standard form.

Do you UNDERSTAND?

5. In 3^5, what is the base? The exponent?

6. In the example at the top, how is 125 written in expanded form?

7. What is the standard form of 3 squared? For 6 cubed?

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*For another example, see Set E on page 75.

The **base** is the number to be multiplied.

The **exponent** is the number that tells how many times the base is used as a factor.

factors   exponent

$5 \times 5 \times 5 = 5^3$

base

Numbers involving exponents can be written in three different forms.

Exponential notation	5^3
Standard form	125
Expanded form	$5 \times 5 \times 5$

Independent Practice

In **8** through **14**, write in exponential notation.

8. $10 \times 10 \times 10 \times 10 \times 10$ **9.** $9 \times 9 \times 9$ **10.** 81×81 **11.** $5 \times 5 \times 5 \times 5$

12. $7 \times 7 \times 7$ **13.** $13 \times 13 \times 13 \times 13 \times 13 \times 13$ **14.** $6 \times 6 \times 6 \times 6$

In **15** through **22**, write in expanded form.

15. 17^5 **16.** 35 squared   **17.** 4^3 **18.** 7^6

19. 55^4 **20.** 11^6 **21.** 8 cubed   **22.** 1^9

In **23** through **30** write in standard form.

23. 5^4 **24.** 10^3 **25.** $4 \times 4 \times 4$ **26.** 12 squared

27. 1^{10} **28.** 2^6 **29.** 3 cubed   **30.** 9^4

Problem Solving

31. Writing to Explain Why is the standard form of 8^2 NOT equal to 16?

32. Number Sense Find the number that equals 81 when it is squared.

33. Darnell earned $10 each week for 10 weeks walking a neighbor's dog.
  a How much did he earn?
  b Write the amount Darnell earned using exponential notation.

34. Which of the following, when written in standard form, is equal to the standard form of 2^6?
  A 6^2 **C** 8^2
  B 3^4 **D** 4^4

Problem Solving

Multiple-Step Problems

Monica wants to buy all of the fruit shown on this sign. She has coupons for $0.45 off the cost of one pint of blueberries, and $0.35 off one watermelon. What will Monica's total cost be after the discounts?

FRESH FRUIT TODAY		
🍎	(3 lb)	$1.29
🫐	(1 pt)	$3.29
🍌	(2 lb)	$0.92
🥒	(each)	$5.65

Another Example

A children's news and talk show is broadcast for 2 hours each weekday. On Saturday and Sunday, the show is an hour longer than during the week. How many hours is this show broadcast each week?

What is one hidden question?

How many hours of the show are broadcast during weekdays?

? total hours

2	2	2	2	2

↑
hours per weekday
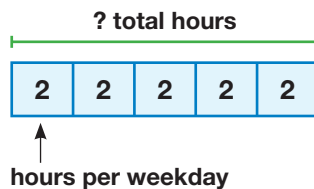
$5 \times 2 = 10$

The show is on for 10 hours during weekdays.

What is another hidden question?

How many hours of the show are broadcast during the weekend?

? total hours

3	3

↑
hours per weekend day
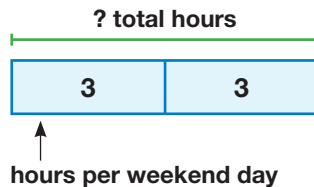
$2 \times 3 = 6$

The show is on for 6 hours during the weekend.

Add the number of weekday and weekend hours.

10 weekday hours + 6 weekend hours = 16 hours
The show is on for 16 hours each week.

Check for reasonableness: I can estimate 2 hrs × 7 days = 14 hrs. This is close to 16 hrs.

Explain It

1. Why do you find and answer the hidden questions before solving the problem?

What do I know?

Monica wants to buy the fruit with prices shown on a store sign. She has coupons for $0.45 and $0.35 off the price of one pint of blueberries and one watermelon.

What am I asked to find?

The cost of all the fruit after the discount

Plan and Solve

Find and answer the hidden question or questions.

1. How much does the fruit cost?

? total cost			
$1.29	$3.29	$0.92	$5.65

$1.29 + $3.29 + $0.92 + $5.65 = $11.15

2. How much are the coupons worth?

? total saved	
$0.45	$0.35

$$\begin{array}{r} \$0.45 \\ + \$0.35 \\ \hline \$0.80 \end{array}$$

Subtract the total saved from the cost of the fruit.
$11.15 − $0.80 = $10.35

Monica will pay $10.35 for the fruit after the discount.

Guided Practice*

Do you know HOW?

Solve.

1. Nate has a $5 bill and a $10 bill. He spends $2.50 for a smoothie and $2 for a muffin. How much money does he have left?

Do you UNDERSTAND?

2. What are the hidden questions and answers for Problem 1?

3. **Write a Problem** Write a real-world multiple-step problem that can be solved using addition and subtraction.

Independent Practice

In **4** through **6**, write and answer the hidden question or questions. Then solve.

4. Elias saved $30 in July, $21 in August, and $50 in September. He spent $18 on movies and $26 on gas. How much money does Elias have left?

5. Paige takes riding lessons 5 days per week for 2 hours each day. Maggie takes guitar lessons twice a week for $2\frac{1}{2}$ hours each day, and piano lessons three days per week for 1 hour each day. Which girl spends more hours on lessons? How many more hours?

6. Lonny planted 15 roses, 12 geraniums, and 6 daisies. His dog digs up 4 roses and 2 daisies. How many flowers are left planted?

Stuck? Try this....

• What do I know?
• What am I asked to find?
• What diagram can I use to help understand the problem?
• Can I use addition, subtraction, multiplication, or division?
• Is all of my work correct?
• Did I answer the right question?
• Is my answer reasonable?

For another example, see Set F on page 75.

For **7** and **8**, write and answer the hidden question or questions. Then solve.

Driving Log

	Business	Personal Use
Monday	48 mi	11 mi
Tuesday	59 mi	8 mi
Wednesday	78 mi	28 mi

7. At the right is a driving log that Mr. Smith kept for the last three days of his trip. How many more miles did he drive for business than for personal use?

8. The table at the right shows the amount of salad a deli had on Monday morning. During the morning, the deli served 5 lb of macaroni salad, 16 lb of pasta salad, and 14 lb of potato salad. How many total pounds of salad did the deli have left Monday afternoon?

Salad Inventory

Macaroni Salad	11 lb
Pasta Salad	22 lb
Potato Salad	15 lb

9. At the craft festival, Tuan spent $12 for food, $19.50 for a small painting, and $6 for a straw hat. Tuan had $4 left. How much did Tuan spend on the small painting and the hat together? Draw a picture and write an equation to solve.

10. Look for a pattern, and then describe it. What are the missing numbers?

0.39, 0.45, 0.51, ▢ , ▢ , ▢

11. Writing to Explain Pull-over shirts cost $24.95 each. Describe how to estimate the cost of 4 shirts. What is the estimate?

Think About the Process

12. A men's store has 63 blue oxford shirts and 44 tan oxford shirts. The same store has 39 red rugby shirts. Which hidden question needs to be answered to find the difference between the number of oxford shirts and rugby shirts?

A How many oxford shirts does the store have?

B How many blue and red shirts does the store have?

C How many total shirts does the store have?

D Why does the store sell oxford shirts?

13. Rita budgeted $250 to refurnish her home. She spent $156 on two rugs and $205 on a new lamp. Rita wants to know how much more money she'll need. Which expression can be evaluated to answer this hidden question: How much has Rita spent on the rugs and the lamps?

A $156 + $205

B $250 − $156

C $156 + $250

D $250 + $205

Algebra Connections

Changing Words to Expressions

Remember that words can be translated to numerical expressions. Sometimes there is more than one word phrase for a numerical expression.

Example:

Word Phrase	Numerical Expression
• twenty minus five	$20 - 5$
• five less than twenty	
• the difference of twenty and five	

For **1** through **16**, write a numerical expression for each word phrase.

1. ten more than thirty

2. twelve fewer than fifty

3. twice as many as ten

4. one less than thirty

5. three times twelve

6. four minus three

7. the product of two and four

8. the sum of one and two

9. thirty more than ten

10. fifty divided by ten

11. three times fifty

12. six groups of three

13. the quotient of four and two

14. fifty less twelve

15. the total of ten and twenty

16. six more than a hundred

17. A person's height is x feet. Which expression represents the height in yards?

$3x$ $\qquad$ $x \div 3$ $\qquad$ $x + 3$

18. A yard has 36 inches. Which expression represents the number of inches in y yards?

$36y$ $\qquad$ $y \div 36$ $\qquad$ $y + 36$

19. A room is f feet long. Which expression represents the length of the room in inches?

$12f$ $\qquad$ $f + 12$ $\qquad$ $f \div 12$

1. Dr. Peterson works about 11 hours each day. Which of the following can be used to find the best estimate of the number of hours he works in 48 days? (3-2)

A 10×40

B 9×50

C 10×50

D 15×45

2. What number makes the number sentence true? (3-1)

$(4 \times 8) \times 7 = 4 \times (8 \times)$

A 3

B 7

C 28

D 56

3. At a garage sale, Josefina bought a TV for $34 and a couch for $79. If she used three $50 bills to pay for the items, how many dollars in change did she receive? (3-7)

A $113

B $37

C $16

D $13

4. A small town newspaper prints 8,250 copies each day. How many copies will the newspaper print in 365 days? (3-5)

A 115,500

B 301,250

C 2,565,750

D 3,011,250

5. A CD costs $9. The table shows the sales of that CD by a store. What was the total value of the sales in September? (3-3)

Month	Number of CDs Sold
August	1,104
September	1,521
October	1,003
November	1,253
December	1,642

Data

A $9,589

B $9,689

C $13,589

D $13,689

6. Jason drives 21 miles to work and 21 miles back home each day. Which of the following is the best estimate of how many miles he drives in 28 days? (3-2)

A 1,200

B 900

C 400

D 300

7. Rosemary reads 295 words per minute. If she reads 3.5 hours a day for 5 days, she will read 1,050 minutes. Which of the following is the best estimate of the number of words she can read in 1,050 minutes? (3-5)

A 300,000

B 200,000

C 30,000

D 20,000

8. Mt. Waialeale in Hawaii has an average rainfall of 460 inches per year. How much rain would this location expect to receive in 5 years? (3-3)

   A 2,000

   B 2,030

   C 2,300

   D 2,305

9. A banana contains 105 calories. Last week, Brendan ate 14 bananas. How many calories were in the bananas that Brendan ate last week? (3-4)

   A 525

   B 1,450

   C 1,470

   D 4,305

10. Which of the following is the best estimate of $4 \times 26 \times 7$ using compatible numbers? (3-2)

   A 800

   B 700

   C 650

   D 400

11. Monica bought a skirt for $15 and a hat for $12. Which of the following is a way to find how much change she would get from $40? (3-7)

   A Add 40 to the difference of 15 and 12

   B Add 12 to the difference of 40 and 15

   C Subtract the sum of 15 and 12 from 40

   D Subtract 15 from the sum of 12 and 40

12. What is $48 \times 2{,}375$? (3-4)

   A 114,000

   B 113,920

   C 109,500

   D 28,500

13. Which of the following is equal to 4^5? (3-6)

   A 4×5

   B $5 \times 5 \times 5 \times 5$

   C $4 \times 4 \times 4 \times 4$

   D $4 \times 4 \times 4 \times 4 \times 4$

14. Four bags with 7 apples in each bag is the same amount as 7 bags with 4 apples in each bag. Which property of multiplication does this represent? (3-1)

   A Commutative

   B Associative

   C Identity

   D Zero

15. A cube with sides 2 inches long has a volume of 2^3 cubic inches. Which of the following is equal to 2^3? (3-6)

   A 6

   B 8

   C 9

   D 36

Set A, pages 52–53

Recall the multiplication properties.

<table>
<tr><th colspan="2" style="background:#0a3d91;color:white">Property of Multiplication</th><th>Example</th></tr>
<tr><td rowspan="8">Data</td><td>Commutative</td><td>$4 \times 8 = 8 \times 4$
$32 = 32$</td></tr>
<tr><td>Associative</td><td>$(4 \times 5) \times 6 = 4 \times (5 \times 6)$
$120 = 120$</td></tr>
<tr><td>Zero</td><td>$12 \times 0 = 0$</td></tr>
<tr><td>Identity</td><td>$9 \times 1 = 9$</td></tr>
</table>

Remember that properties of multiplication can help you find products more easily.

Identify the multiplication property.

1. $625 \times 1 = 625$

2. $9 \times 2 = 2 \times 9$

3. $2 \times (3 \times 4) = (2 \times 3) \times 4$

4. $0 \times 451 = 0$

Complete the following equations.

5. $1 \times 6{,}984 = \square$

6. $78 \times 4 = 4 \times \square$

7. $\square \times (75 \times 62) = (81 \times 75) \times 62$

Set B, pages 54–55

Estimate 37×88.

Step 1   Round both factors.   37 is about 40 and 88 is about 90.

Step 2   Multiply the rounded factors. $40 \times 90 = 3{,}600$

Remember to either round the factors or use compatible numbers when estimating.

1. 7×396 **2.** 17×63

3. 91×51 **4.** 70×523

5. 32×400 **6.** 116×787

7. $4 \times 24 \times 91$ **8.** $29 \times 51 \times 67$

Set C, pages 56–58

Find 193×5. Estimate: $200 \times 5 = 1{,}000$

Step 1
Multiply ones. Regroup if needed.

$$\begin{array}{r} 1 \\ 19\mathbf{3} \\ \times \quad \mathbf{5} \\ \hline 5 \end{array}$$

Step 2
Multiply tens. Add extra tens. Regroup if necessary.

$$\begin{array}{r} 4\,1 \\ 1\mathbf{9}3 \\ \times \quad \mathbf{5} \\ \hline 65 \end{array}$$

Step 3
Multiply hundreds. Add extra hundreds. Regroup if necessary.

$$\begin{array}{r} 4\,1 \\ \mathbf{1}93 \\ \times \quad \mathbf{5} \\ \hline 965 \end{array}$$

Remember that you can round to estimate first.

Multiply. Check for reasonableness.

1. 672×6 **2.** 99×4

3. $1{,}074 \times 9$ **4.** 26×5

5. $1{,}306 \times 9$ **6.** $5{,}984 \times 2$

7. $9{,}511 \times 6$ **8.** 998×9

Set D, pages 60–62, 64–65

Find 425 × 38. Estimate: 400 × 40 = 16,000

Step 1
Multiply the ones.

$$
\begin{array}{r}
{\scriptstyle 2\,4} \\
425 \\
\times\ \ \ 38 \\
\hline
3400
\end{array}
$$

Step 3
Multiply the tens.

$$
\begin{array}{r}
{\scriptstyle 1} \\
425 \\
\times\ \ \ 38 \\
\hline
3400 \\
12750
\end{array}
$$

Step 3
Add the partial products.

$$
\begin{array}{r}
425 \\
\times\ \ \ 38 \\
\hline
3400 \\
+\ 12750 \\
\hline
16,150
\end{array}
$$

Remember to regroup if necessary. Estimate to check that your answer is reasonable.

1. 67 × 48 **2.** 81 × 19

3. 51 × 605 **4.** 32 × 871

5. 3,345 × 472 **6.** 192 × 2,497

7. 9,413 × 162 **8.** 4,706 × 980

Set E, pages 66–67

Write 7^3 in expanded form and standard form.

Tip *The base is 7. The exponent is 3.*

Expanded form: 7 × 7 × 7
Exponential notation: 7^3
Standard form: 343

Remember that the exponent tells how many times the base is used as a factor.

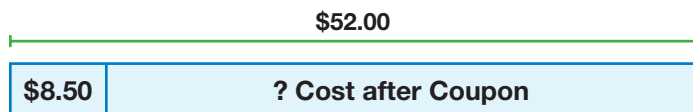Write each in expanded form and standard form.

1. 17^2 **2.** 10^5 **3.** 2^6 **4.** 5^4

Set F, pages 68–70

Gene wants to buy a catcher's mitt for $52.00 and a pair of baseball shoes for $95.75. He has a coupon for $8.50 off the price of the mitt. How much will Gene owe for his purchase?

What is the hidden question or questions?

What will Gene pay for the mitt after the coupon?

$52.00	
$8.50	? Cost after Coupon

$52.00 − $8.50 = $43.50

Now, add the discounted price of the mitt to the price of the shoes to find Gene's total.

$43.50 + $95.75 = $139.25

Remember to look for the hidden question or questions before solving.

Write and answer the hidden question or questions. Then solve.

1. Pedro earned $13.50 for mowing lawns, $11 for raking leaves, and $14.75 for walking dogs. If Pedro bought a magazine subscription for $16.95 from his earnings, how much money did he have left?