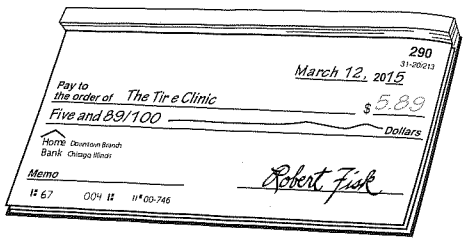
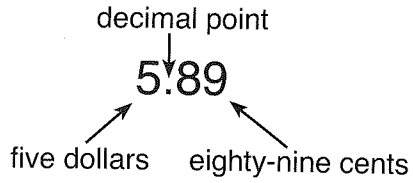
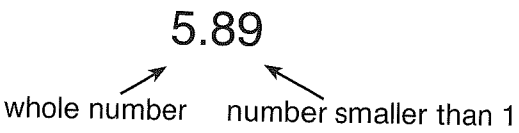
UNDERSTANDING DECIMALS

Each time you use money, you are working with decimals. In the U.S. money system, a **decimal point** separates dollars from cents. Numbers after the decimal point represent a value *less than $1.*



Similarly, our number system uses the decimal point to separate whole numbers from numbers with a value *less than 1.*





A digit's position in relation to the decimal point (its place value) tells you how large or small it is. Look at the place value chart below.

ten thousands	thousands		hundreds	tens	ones		tenths	hundredths	thousandths	ten thousandths
7	0	,	6	9	3	.	1	0	5	8

TIP

Numbers after the decimal point end in ths: *tenths, hundredths, thousandths, and so on.*

What place is the 9 in?
It represents 9 *tens,* or 90.

What place is the 5 in?
It represents the fraction 5 *thousandths,* or $\frac{5}{1000}$.

There are two zeros in the number. Both are used as placeholders. In this number, there are no thousands and no hundredths.

Decimal values can be less than ten thousandths, just as whole numbers can be greater than ten thousands. The place value columns continue in both directions. Columns increase in value as they go to the left and decrease as they go to the right.

UNDERSTANDING THE VALUE OF A DECIMAL

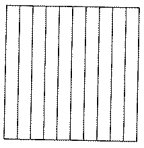
Example Which is larger: 0.5 or 0.05?

Step 1
Look at the place value of the last digit in the decimal.

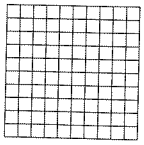
0.5
The place value is tenths.

0.05
The place value is hundredths.

Step 2
Think of a box divided into that many parts.

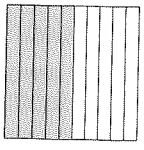


divided into tenths

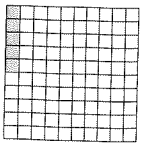


divided into hundredths

Step 3
Visualize the whole decimal as part of that box.



5 tenths (0.5)



5 hundredths (0.05)

5 tenths is larger than 5 hundredths.

Fill in the blanks below.

1. A mile is equal to 1,609.344 meters.
   a. The 3 is in the _____ place.
   b. The 6 is in the _____ place.
   c. There are 4s in both the _____ and _____ places.

2. In the number 3,059.182, what digit is in the
   a. tens place? _____
   b. tenths place? _____
   c. ones place? _____
   d. hundredths place? _____

3. In the number 6,106.65, what digit is in the
   a. tens place? _____
   b. tenths place? _____
   c. ones place? _____
   d. hundredths place? _____

Choose the correct answer.

4. A library book has the number 791.48 on its spine. Which of the digits is in the tenths place?
   A. 9
   B. 8
   C. 4
   D. 1

5. A security guard walks an average of 4.375 miles per day. What part of a mile does the digit 5 represent?
   A. ten thousandths
   B. thousandths
   C. hundredths
   D. tenths

Four calculator displays are shown here. The fourth display is blank. Use the clues to figure out the contents of the fourth display.

Clue 1: There are no hundredths in the fourth display.

Clue 2: The fourth display has more tenths than the third display but fewer tenths than the first.

Clue 3: There are 4 times as many thousandths in the fourth display as there are in the third display.

Display 1: 0.375

Display 2: 0.046

Display 3: 0.182

Display 4: 0._____ _____ _____

6. Explain What is the number in the fourth display? How do you know?

Answers start on page 179.

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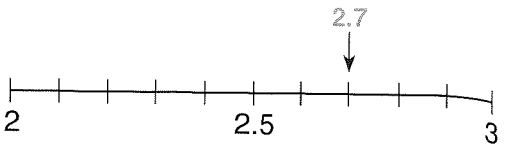
ROUNDING DECIMALS

Look at the number line. Is the decimal 2.7 closer to 2 or to 3?

The decimal 2.7 rounds to the whole number 3.



Rounding to the nearest whole number means to figure out which whole number the decimal is closest to. You often round to the nearest whole number when you shop.

Example At the drug store, you buy items costing $3.99, $5.29, and $7.89. You have a $20 bill. Do you have enough money?

You can use rounding to estimate the amount of money the items cost. Round each item to the nearest dollar.

$3.99 rounds to $4
$5.29 rounds to $5
$7.89 rounds to $8

Add:
$4
$5
+ $8
$17

Even adding about $2 for sales tax, you should have enough money.

To round a decimal to a certain place value, look at the decimal to the right of the desired place.

ROUNDING A DECIMAL TO A GIVEN PLACE VALUE

Example Round 13.648 and 13.6712 to the nearest tenth.

Step 1
Identify the place you need to round to. Many students find it useful to underline this digit.

Step 2
Look at the digit immediately to the right of the underlined digit.

13.648

If the digit to the right is less than 5, leave the underlined digit as is. Drop all the remaining digits to the right.

13.648 4 is less than 5. The digit doesn't change.

13.648 rounds to **13.6**

13.6712

If the digit to the right is 5 or more, add 1 to the underlined digit and drop the remaining digits.

13.6712 7 is more than 5. Add 1 to the 6 and drop the rest.

13.6712 rounds to **13.7**

Knowing how to round is crucial to interpreting calculator results.

After dividing $9 by 7, a calculator display reads: 9÷7 1.285714286

To round to 2 decimal places, you need 3 places. The thousandths place is equal to 5, so round up and drop the remaining digits.

1.285 rounds to 1.29

Round to the nearest whole number.

1. 12.8 1.6 5.08

2. 20.5 20.4 20.099

For each calculator display, round to the nearest tenth, hundredth, and thousandth.

			tenth	hundredth	thousandth
3.	69÷16	4.3125	_____	_____	_____
4.	5÷12	0.416666667	_____	_____	_____
5.	5÷32	0.15625	_____	_____	_____

Choose the correct answer for each problem.

6. The rainfall for a 3-month period was 8.51 inches. To the nearest inch, how many inches of rain fell?
   A. 7
   B. 8
   C. 9
   D. 10

7. John is 1.905 meters tall. What is his height to the nearest tenth meter?
   A. 1.0
   B. 1.8
   C. 1.9
   D. 2.0

8. When rounded to the nearest cent, which of these amounts rounds to $15.60?
   A. $15.465
   B. $15.591
   C. $15.593
   D. $15.595

9. A credit card has a thickness of 0.076 centimeters. What is the thickness to the nearest tenth centimeter?
   A. 1.0
   B. 0.1
   C. 0.8
   D. 0.08

10. Seven friends are splitting the cost of a meal. Tom plans to divide the total by 7 and then round to the nearest cent. For how many decimal places will he need to continue the division to be able to round as planned?
   A. 2
   B. 3
   C. 4
   D. 5

Answers start on page 180.

ADDING AND SUBTRACTING DECIMALS

Before you add or subtract decimals, you must write the numbers in a column with the decimal points aligned. Lining up the decimal points automatically lines up all the place value columns.

Then add placeholder zeros as needed. Finally, add or subtract as you would if you were working with whole numbers.

TIP

A whole number has an "understood" decimal point.

8 = 8. = 8.0 = 8.00

ADDING DECIMALS

Example Janna needs about 6 pounds of turkey for a recipe. She buys 3 packages of ground turkey at the grocery store. The packages weigh 2.75 pounds, 1.5 pounds, and 2 pounds. What is the total weight of the ground turkey?

Step 1
Line up the decimal points. Add placeholder zeros.

```
  2.75
  1.50
+ 2.00
```

Step 2
Add. Write the decimal point in the answer directly below the decimal point in the problem.

```
   1
  2.75
  1.50
+ 2.00
  6.25
```

Check by Estimating
2.75 is almost 3
1.5 is almost 2
3 + 2 + 2 = 7

7 is a little more than **6.25,** so the answer makes sense.

Subtraction works in the same way.

SUBTRACTING DECIMALS

Example A mountain trail is 20.25 miles long. A hiker stops at the 10.8 mile marker to rest. How much farther does he have to hike to the end of the trail?

Step 1
Line up the decimal points. Add placeholder zeros.

```
  20.25
- 10.80
```

Step 2
Subtract. Regroup as needed. Write the decimal point in the answer directly below the decimal point in the problem.

```
   1 9 1
  2Ø.25
- 10.80
   9.45
```

Check by Estimating
20.25 is almost 20
10.8 is almost 11
20 – 11 = 9

9 is close to **9.45,** so the answer is reasonable.

Solve. Use placeholder zeros as needed. Be sure to line up the decimal points.

1.

3.7 + 0.05	13.75 + 36	45.3 + 0.852	17 + 50.38

2.

1.4 + 3.07 + 27	6.8 + 3.5 + 9.6	0.13 + 39.6 + 5.28	0.05 + 4.95 + 9.5

3.

9 − 6.75	24.5 − 16.9	1.078 − 0.36	3.4 − 2.705

4.

8.2 − 7.9	12.85 − 5.87	7 − 5.352	42.6 − 21.92

Solve the problems below.

5. A customer bought items costing $2.74, $0.95, and $5.28. What was the total amount of the sale?

6. To make a recipe, Janet used two cans of beans. The small can contained 8.7 ounces, and the large can contained 15.5 ounces. How many ounces of beans did she use?

7. A customer handed Connie a $20 bill to pay for $13.79 worth of merchandise. How much change did Connie give the customer?

8. Max's employer withholds $176.84 from Max's wages every two weeks. If Max earns $1,105 for two weeks of work, how much is his take-home pay for that period of time?

9. Three transistors weigh 0.516 gram, 0.793 gram, and 0.454 gram. What is the total weight of the transistors?

10. Robin ran the school's 100-meter dash in 12.4 seconds. The school record is 11.875 seconds. How much slower was Robin's time than the record?

11. For lunch, Phil had a veggie burger for $6.25, a cup of coffee for $1.50, and a piece of pie for $3.45. If he paid $0.78 in tax, how much did he spend for lunch?

12. Stuart had a 103.6° temperature at 6 p.m. After he took medicine, his temperature dropped to 99.8°. By how many degrees did his temperature fall?

Answers start on page 180.

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MULTIPLYING DECIMALS

Multiplying decimals is like multiplying whole numbers. You just need to place the decimal point correctly in your answer.

> **TIP**
> *Remember, a whole number has an "understood" decimal point to its right: 4 = 4. = 4.0*

MULTIPLYING A DECIMAL

Example Tom is shipping 8 copies of a book. Each copy weighs 1.8 pounds. How many pounds will his shipment weigh?

Step 1
Estimate first.

1.8 rounds to 2
8 × 2 = 16

Step 2
Line numbers up at the right.

```
 1.8
×  8
```

Step 3
Multiply as you would with whole numbers.

```
 1.8
×  8
 144
```

Step 4
Count the digits after each decimal point in the problem. From the right, count out the same number of decimal places in the answer. Insert the decimal point.

```
 1.8        1 place
×  8      + 0 place
14.4 lb     1 place
  ←
```

Check: Your answer, **14.4 pounds,** is close to the estimate of 16 pounds.

Estimation is still the best way to see if your answer makes sense. Keep in mind that multiplying makes the numbers grow quickly, so your estimate might not be as close to the answer as it is when you are adding or subtracting.

Sometimes when multiplying decimals, you must add a **placeholder zero** in your answer where it is needed to keep the correct number of decimal places.

MULTIPLYING WITH PLACEHOLDER ZEROS

Example What is 0.05 × 0.9?

Step 1
Estimate first.

0.9 is nearly 1.
1 × 0.05 = 0.05

Step 2
Line numbers up at the right.

```
 .05
× .9
```

Step 3
Multiply as you would with whole numbers.

```
 .05
× .9
 45
```

Step 4
Count the digits after each decimal point in the problem. From the right, count out the same number of decimal places in the answer. Insert the decimal point.

```
 .05        2 places
× .9      + 1 place
.045 lb     3 places
 ←←←
```

Add this placeholder zero to get 3 places after the decimal point.

Check: Your answer, **0.045,** is close to your estimate of 0.05.

Put the decimal point in the correct place in each answer below.

1.

12.5 (1 place)	3.4	.007	2.9	.19
× 6.3 (1 place)	× 5	× .6	× .002	× 6
7875 (2 places)	170	42	58	114

Multiply the following decimals. Estimate first. Be careful where you put your decimal point in your final answer.

2. 19 × .63

Estimate

19 ≈ 20

× .63 ≈ × .60

4.7 × 3.8

2.05 × 5

8.75 × 5.1

3. .8 × 3.5

7.7 × 1.9

3.25 × .25

60 × 9.9

Solve the problems below.

4. A roast weighing 4.8 pounds costs $5.50 per pound. What is the cost of the roast?

5. Pam's company pays her 51.5 cents per mile when she uses her car for work. On a business trip, she drove 360 miles. How much will the company pay Pam for miles driven? (***Hint:*** Write 51.5 cents as $0.515.)

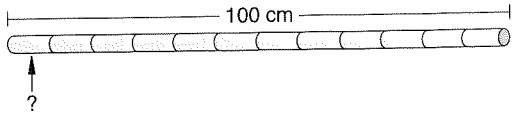
6. A cotton print fabric is $5.60 per yard. How much would it cost to buy 3.75 yards of the fabric?

7. **Explain** Spencer needs to multiply 18.25 by 0.04. He decides to use a calculator. The calculator answer is 0.73. Since the original problem contained four decimal places, he expected the calculator answer to have four decimal places.

Try the multiplication yourself. Why doesn't the calculator answer have four decimal places?

8. A water bottle holds 16.9 fluid ounces of water. How many fluid ounces of water are in a case of 24 bottles?

9. Alan has a wooden dowel that is 100 centimeters in length. He needs to cut 11 pieces, each 8.25 centimeters in length, from the dowel. How many centimeters of dowel will be left over after he makes the cuts?



10. Austin borrowed $1,800 for school expenses. To find his minimum monthly payment, he multiplies the amount he owes by 0.025. How much is his minimum monthly payment?

Answers start on page 181.

DIVIDING DECIMALS

When dividing a decimal by a whole number, be sure you place the decimal point in the correct place.

DIVIDING A DECIMAL BY A WHOLE NUMBER

Example Andrew cut a 16.1-foot board into 4 equal pieces. How long is each piece?

Step 1
Estimate first.

16.1 rounds to 16.
16 ÷ 4 = 4

Step 2
Set up the problem. Place the decimal point directly above the decimal point in the dividend.

$4\overline{)6.1}$

divisor dividend

Step 3
Divide as you would whole numbers.

$$\begin{array}{r} 4.0 \\ 4\overline{)16.1} \\ \underline{16} \\ 1 \end{array}$$

Step 4
Continue dividing. Add zeros if necessary and bring them down.

$$\begin{array}{r} 4.025 \\ 4\overline{)16.100} \\ \underline{16} \\ 10 \\ \underline{8} \\ 20 \\ \underline{20} \\ 0 \end{array}$$

Check: The answer **4.025** is close to the estimate of 4.

When dividing a number by a decimal, first change the divisor to a whole number. Then divide as shown above.

DIVIDING BY A DECIMAL

Example Marisol has a roll of lace that is 90 inches long. How many strips of lace 6.25 inches long can she cut from the roll?

Step 1
Estimate first.

90 rounds to 100.
6.25 is close to 5.
100 ÷ 5 = 20

Your estimate tells you to expect an answer that begins in the tens column.

Step 2
Move the decimal point in the divisor to the right until the divisor is a whole number.

$6.2\overset{\rightarrow}{5}.\overline{)90}$

A whole number is understood to have a decimal point *after* it.

Step 3
Move the decimal point in the dividend *the same number of places.*

$625.\overline{)90.\overset{\rightarrow}{0}\overset{\rightarrow}{0}.}$

Add zeros so you can move the decimal point enough places.

Step 4
Bring the decimal point up from its new position. Divide as usual.

$$\begin{array}{r} 14.4 \\ 625.\overline{)9000.0} \\ \underline{625} \\ 2750 \\ \underline{2500} \\ 250\,0 \\ \underline{250\,0} \\ 0 \end{array}$$

Check: Marisol could cut **14 strips of lace.** Ignore the remaining 0.4 because the problem asks how many whole strips she can cut. You know you placed the decimal point correctly because your answer 14 is *reasonably* close to your estimate of 20.

Solve the following division problems.

1. $6\overline{)6.36}$ $3\overline{).075}$ $.4\overline{)3.4}$ $1.2\overline{)98.4}$

2. $1.792 \div 5.6$ $21.15 \div 9$ $.16 \div 32$ $6.84 \div .36$

Solve the following word problems.

Problems 3 and 4 refer to finding an average.

To find an **average,** *add* a group of numbers, then *divide* the total by the number of items in the group.

Example

Find the average of 2.6, 4.6, and 1.5.

$2.6 + 4.6 + 1.5 = 8.7$
$8.7 \div 3 = 2.9$

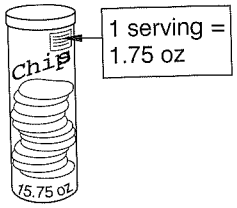
The average is 2.9.

3. Rainfall for the last 3 months was 6.2, 8.5, and 3.9 inches. What was the average rainfall per month for the 3-month period?

4. Craig ran 4 days last week. His distances were 8.25, 6.5, 7.25, and 10.5 kilometers. What was his average distance per day for the 4 days?

5. Four concert tickets cost $154.68. How much does each ticket cost?

6. One serving of potato chips is 1.75 ounces. The entire can of chips holds 15.75 ounces. How many servings are in the can?



Use the table for problems 7 and 8.

Monday	7.75 hours
Tuesday	6.5 hours
Wednesday	7.25 hours
Thursday	8.0 hours
Friday	7.25 hours

7. Evan's work schedule for next week is shown above. What is the average number of hours he is scheduled to work per day?

8. **Explain** Evan's gross pay (before deductions) for the week will be 463.05. How much does he earn per hour? Explain.

9. Carla has $60 to spend on art supplies. Acrylic paint is on sale for $1.85 per tube. How many tubes of paint can she buy? (***Hint:*** Carla can't buy part of a tube of paint.)

10. A land developer wants to subdivide a 14.8-acre piece of land into lots to build homes. If each lot is 0.62 acre in size, how many lots are possible?

Answers start on page 181.

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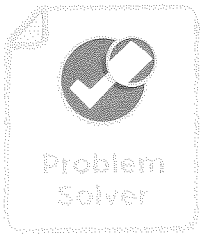
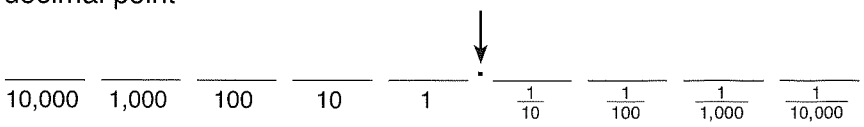


POWERS OF TEN

Our place value system is based on the powers of ten. A power of ten is a 1 followed by any number of zeros. In a place value chart, each place value is 10 times greater than the place value to its right. Look at the numbers on the place value chart. Can you see the patterns the zeros make in the numbers?



You can use these patterns to make multiplication easier.

To multiply a whole number by a power of ten, count the number of zeros in the power of ten. Then add that many zeros to the number.

14 × 1,000	Add 3 zeros: 14,000	14 × 1,000 = 14,000
125 × 100	Add 2 zeros: 12,500	125 × 100 = 12,500

To multiply a decimal by a power of ten, count the number of zeros in the power of ten. Then move the decimal point that same number of places to the right.

2.6 × 10	Move the point 1 place to the right.	2.6 × 10 = 2.6. = 26
2.6 × 100	Move the point 2 places to the right.	2.6 × 100 = 2.60. = 260 placeholder zero
2.6 × 1,000	Move the point 3 places to the right.	2.6 × 1000 = 2.600. = 2,600 placeholder zeros

Multiply.

1. 190 × 10	42 × 1,000	560 × 10,000	400 × 100
2. 6.5 × 10	3.47 × 10	16.8 × 100	5.32 × 1,000
3. 10.05 × 100	3.032 × 10	1.125 × 1,000	.375 × 100

To divide by a power of ten, count the number of zeros in the power of ten. Then move the decimal point that same number of places to the left.

$13.5 \div 10$	Move the point 1 place to the left.	$13.5 \div 10 = 1.3.5 = 1.35$
$13.5 \div 100$	Move the point 2 places to the left.	$13.5 \div 100 = .13.5 = 0.135$
$13.5 \div 1{,}000$	Move the point 3 places to the left.	$13.5 \div 1000 = .013.5 = 0.0135$

Add zeros as necessary.

Divide.

4. $15.72 \div 10$	$2{,}058 \div 1{,}000$	$25.5 \div 10$	$0.06 \div 100$
5. $600 \div 10$	$0.8 \div 100$	$6.1 \div 100$	$0.14 \div 100$
6. $36 \div 10$	$7.2 \div 100$	$10.5 \div 1{,}000$	$9 \div 10{,}000$

CORE CONNECTIONS: Multiplying with Zeros

Placeholder zeros keep digits in the correct place value columns, but when you multiply, zeros at the end of numbers can create confusion.

You can use what you know about the powers of ten to make it easier to multiply whole numbers that end in zero.

Example Multiply 1,300 by 500.

Step 1
Count the *ending* zeros in the problem. There are 4 ending zeros.

$$\begin{array}{r} 1{,}300 \\ \times\ 500 \\ \hline \end{array}$$

Step 2
Multiply the numbers without the zeros.

$$\begin{array}{r} 13 \\ \times\ 5 \\ \hline 65 \end{array}$$

Step 3
Include the ending zeros.

With the 4 ending zeros, 65 becomes 650,000

$1{,}300 \times 500 =$ **650,000**

Multiply.

1. 40×20	$1{,}500 \times 300$	160×900	340×120
2. $5{,}500 \times 40$	250×600	$10{,}700 \times 30$	$8{,}200 \times 700$

Answers start on page 181.