Name ________________________ Date ______________ Class______________

LESSON 1-1

Rational and Irrational Numbers

Practice and Problem Solving: A/B

Write each fraction as a decimal.

1. $\frac{1}{8}$ ____________
2. $\frac{9}{16}$ ____________
3. $\frac{11}{20}$ ____________
4. $5\frac{8}{25}$ ____________
5. $\frac{14}{15}$ ____________
6. $2\frac{7}{12}$ ____________
7. $\frac{3}{100}$ ____________
8. $\frac{16}{5}$ ____________

Find the two square roots of each number.

9. 25 ____________
10. 1 ____________
11. $\frac{25}{4}$ ____________
12. $\frac{121}{49}$ ____________

Find the cube root of each number.

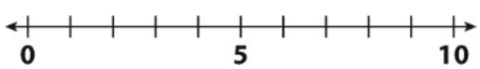
13. 8 ____________
14. 216 ____________
15. 1 ____________
16. 2197 ____________

Approximate each irrational number to the nearest hundredth without using a calculator.

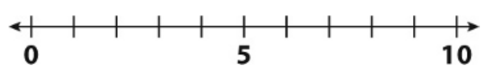
17. $\sqrt{32}$ ____________
18. $\sqrt{118}$ ____________
19. $\sqrt{18}$ ____________
20. $\sqrt{319}$ ____________

Approximate each irrational number to the nearest hundredth without using a calculator. Then plot each number on a number line.

21. $\sqrt{8}$ ______________



22. $\sqrt{75}$ ______________



23. A tablet weighs 1.23 pounds. What is its weight written as a mixed number?

____

24. The area of a square mirror is 256 in^2. A rectangular mirror has a width the same as the square mirror's width. Its length is two inches longer than its width. What is the area of the rectangular mirror?

____

Name ____ Date __________________ Class__________________

LESSON 1-1

Rational and Irrational Numbers

Practice and Problem Solving: C

Solve.

1. One nickel is $\frac{39}{500}$ inch thick. Fifteen nickels are stacked vertically. How many inches tall is the stack? Give your answer as a decimal.

____

2. One quarter is $\frac{191}{200}$ inch in diameter. Eight quarters are placed side-by-side along a line. How many inches long is the line of quarters? Give your answer as a decimal.

____

3. Is $\frac{41}{50}$ closer to $\frac{9}{11}$ or $\frac{10}{11}$? Verify your answer.

____

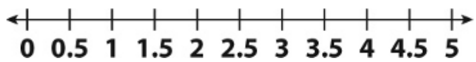
____

Find the two square roots of each number. (Hint: First write the decimal as a fraction.)

4. 0.25 _______________ 5. 0.0625 _______________ 6. $0.\overline{4}$ _______________

Approximate each irrational number to the nearest hundredth without using a calculator. Then plot each lettered point on the number line.

7. *A*: $\sqrt{3}$ _______________ 8. *B:* $\sqrt{18}$ _______________



Answer the questions below.

9. How does finding a cube root differ from finding a square root of a positive integer? How do the answers differ?

____

____

10. Each page of a photo album holds 3 rows of 4 square photos. The area of each photo is 25 cm^2. There is 2 cm space between photos and a 3 cm border around the group of pictures. What are the dimensions of one page of the photo album?

____

Name ______________________ Date ______________ Class ______________

LESSON 1-1

Rational and Irrational Numbers

Practice and Problem Solving: D

Write each fraction as a decimal. The first one is done for you.

1. $\frac{1}{9}$ **$0.\overline{1}$**
2. $\frac{11}{20}$ ________
3. $\frac{9}{16}$ ________

Write each decimal as a fraction in simplest form. The first one is done for you.

4. 0.258 $\mathbf{\frac{258}{1000} = \frac{129}{500}}$
5. 4.8 ________
6. 0.333 ________

Find the two square roots of each number. The first one is done for you.

7. 16 **4, –4**
8. 49 ________
9. $\frac{25}{4}$ ________

Find the cube root of each number. The first one is done for you.

10. 343 **$7 \times 7 \times 7 = 343$, 7**
11. 1 ________
12. $\frac{8}{27}$ ________

Approximate each irrational number to the nearest hundredth without using a calculator. The first one is done for you.

13. $\sqrt{32}$ **5.66**
14. $\sqrt{59}$ ________
15. $\sqrt{118}$ ________

Solve.

16. The world's smallest country is Vatican City. It covers $\frac{17}{100}$ square mile. What is Vatican City's area written as a decimal?

____

17. A square sandbox has an area of 25 ft^2. What is the length of each of its sides? (Hint: side = $\sqrt{25}$)

____

Name ______________________________ Date ______________ Class______________

LESSON 1-1

Rational and Irrational Numbers

Reteach

To write a fraction as a decimal, divide the numerator by the denominator.

A decimal may terminate.

$$\frac{3}{4} = 4\overline{)3.00}$$
$$\begin{array}{r} 0.75 \\ 4\overline{)3.00} \\ \underline{-28\downarrow} \\ 20 \\ \underline{-20} \\ 0 \end{array}$$

A decimal may repeat.

$$\frac{1}{3} = 3\overline{)1.00}$$
$$\begin{array}{r} 0.\overline{3} \\ 3\overline{)1.00} \\ \underline{-9\downarrow} \\ 10 \\ \underline{-\ 9} \\ 1 \end{array}$$

Complete to write each fraction as a decimal.

1. $\frac{15}{4} = 4\overline{)15.00}$

2. $\frac{5}{6} = 6\overline{)5.00}$

3. $\frac{11}{3} = 3\overline{)11.00}$

Every positive number has two square roots, one positive and one negative.

Since $5 \times 5 = 25$ and also $-5 \times -5 = 25$, both 5 and -5 are square roots of 25.

$\sqrt{25} = 5$ and $-\sqrt{25} = -5$

Every positive number has one cube root.
Since $4 \times 4 \times 4 = 64$, 4 is the cube root of 64.

Find the two square roots for each number.

4. 81 ____________________

5. 49 ____________________

6. $\frac{25}{36}$ ____________________

Find the cube root for each number.

7. 27 ____________________

8. 125 ____________________

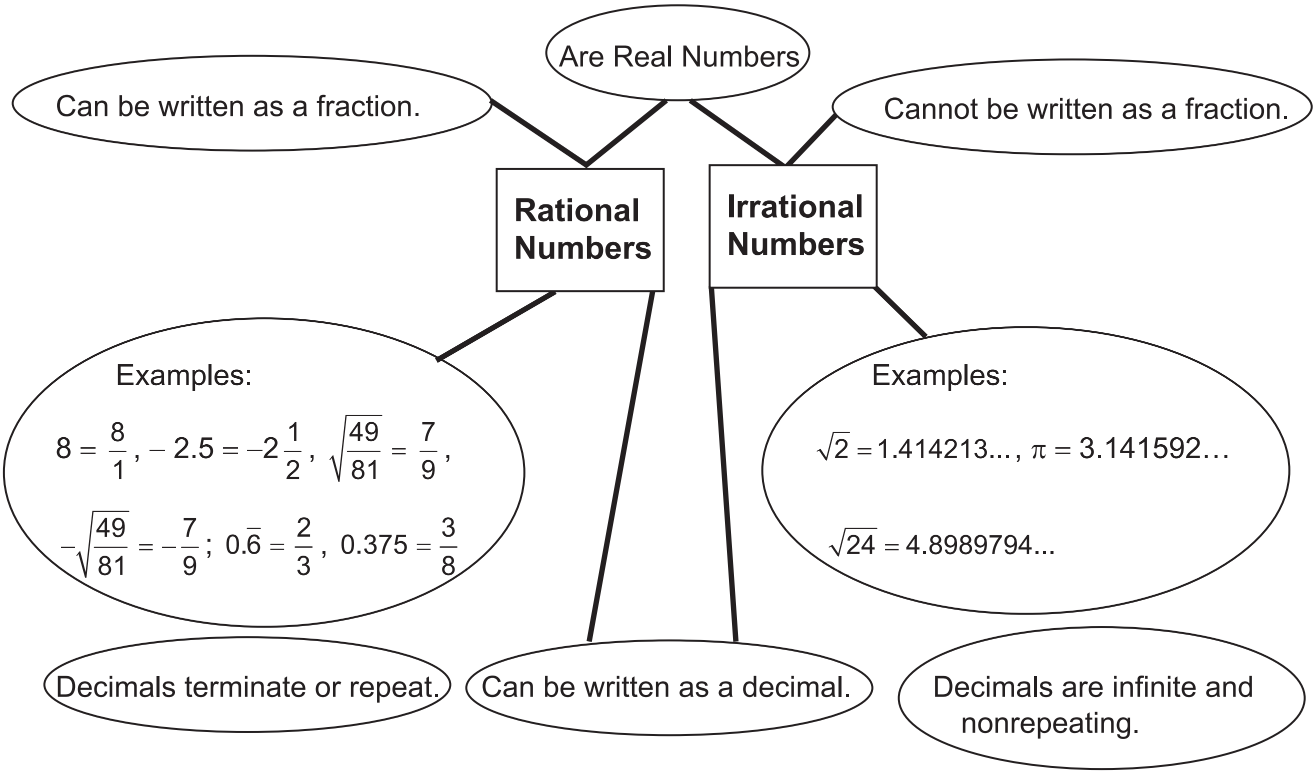
9. 729 ____________________

Name ______________________ Date ______________ Class______________

LESSON 1-1

Rational and Irrational Numbers

Reading Strategies: Compare and Contrast



Use the chart to answer the following questions.

1. Is 0.62 a rational number? Why or why not?

____

2. Is $\sqrt{7}$ a rational number? Why or why not?

____

3. Can an irrational number be a decimal? If so, give an example.

____

4. Can a rational number be a repeating decimal? If so, give an example.

____

5. What kind of decimal is an irrational number? Give an example.

____

____

6. What do rational and irrational numbers have in common?

____

Name ______________________________ Date ______________ Class______________

LESSON 1-1

Rational and Irrational Numbers

Success for English Learners

Problem 1

Think about decimal equivalents of common fractions to rewrite $\frac{2}{3}$ as a decimal.

$\frac{1}{2} = 0.5$ $\quad\quad$ $\frac{1}{4} = 0.25$ $\quad\quad$ $\frac{1}{3} = 0.\overline{3}$ $\quad\quad$ $\frac{3}{4} = 0.75$ $\quad\quad$ $\frac{2}{3} = 0.\overline{6}$

So, $\frac{2}{3} = 0.\overline{6}$.

Problem 2

Think: What number times itself equals 81?

$\sqrt{81}$

$\sqrt{81} = 9$

$-\sqrt{81} = -9$

$4 \times 4 = 16$	$-4 \times -4 = 16$
$5 \times 5 = 25$	$-5 \times -5 = 25$
$6 \times 6 = 36$	$-6 \times -6 = 36$
$7 \times 7 = 49$	$-7 \times -7 = 49$
$8 \times 8 = 64$	$-8 \times -8 = 64$
$9 \times 9 = 81$	$-9 \times -9 = 81$

Problem 3

$\sqrt{700} \approx 26.5$

What is this?

It reads "the square root of 700 is about 26.5."

$\approx$ means ABOUT

1. Which decimal equivalent of a common fraction would you use to rewrite $1\frac{1}{4}$ as a decimal?

____

2. Why is 5^2 read as "five squared"?

____

____

3. Why do you use the term "about" when reading the answer to Problem 3 above?

____

Name ______________________ Date ____________ Class____________

LESSON 1-2

Sets of Real Numbers

Practice and Problem Solving: A/B

List all number sets that apply to each number.

1. $-\frac{4}{5}$ ________________

2. $\sqrt{15}$ ________________

3. –2 ________________

4. –25 ________________

5. $0.\overline{3}$ ________________

6. $\frac{20}{4}$ ________________

Tell whether the given statement is true or false. Explain your choice.

7. All real numbers are rational.

____

8. All whole numbers are integers.

____

Identify the set of numbers that best describes each situation. Explain your choice.

9. the amount of money in a bank account

____

10. the exact temperature of a glass of water in degrees Celsius

____

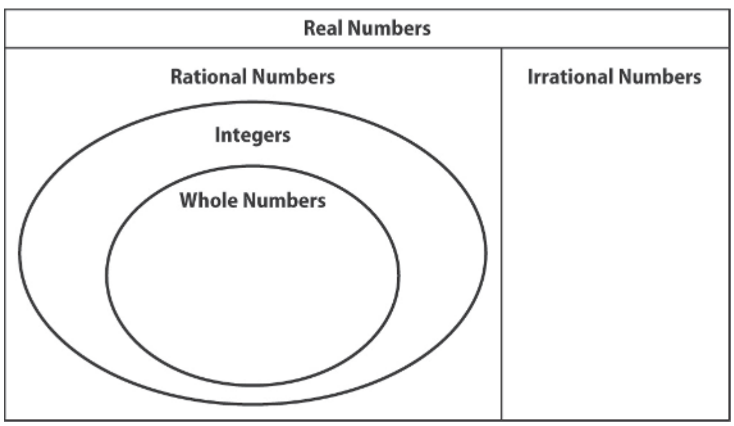
Place each number in the correct location on the Venn diagram.

11. $-\frac{5}{9}$

12. $-\sqrt{100}$

13. π

14. $\sqrt{25}$



Name ______________________ Date ______________ Class______________

LESSON 1-2

Sets of Real Numbers

Practice and Problem Solving: C

List all number sets that apply to each number.

1. $-\sqrt{36}$

____

2. $-\dfrac{16}{2}$

____

3. 0.125185623

____

4. $\dfrac{\sqrt{25}}{5}$

____

5. $\dfrac{18}{19}$

____

6. $\dfrac{4}{5} \bullet \dfrac{10}{4}$

____

Identify the set of numbers that best describes each situation. Explain your choice.

7. the possible scores in a card game in which points are added or deducted after each hand

____

8. elevation of land compared to sea level

____

Answer each question.

9. Is it possible to count the number of rational numbers there are between any two integers?

____

10. If you take the square root of every whole number from 1 through 100, how many of them will be whole numbers? How many will be irrational numbers?

____

11. What numbers are integers but not whole numbers?

____

12. What negative numbers are not integers?

____

Name ______________________________ Date ______________ Class______________

LESSON 1-2

Sets of Real Numbers

Practice and Problem Solving: D

List all number sets that apply to each number. The first one is done for you.

1. $-\frac{1}{2}$

   real, rational

2. $\sqrt{3}$

   ____

3. 0.9

   ____

4. –3

   ____

5. $0.\overline{6}$

   ____

6. 18

   ____

Tell whether the given statement is true or false. Explain your choice.

7. All fractions are real numbers.

   ____

8. All negative numbers are integers.

   ____

Identify the set of numbers that best describes each situation. Explain your choice.

9. the number of people in a movie theater

   ____

10. roll a pair of number cubes and take the square root of the sum

   ____

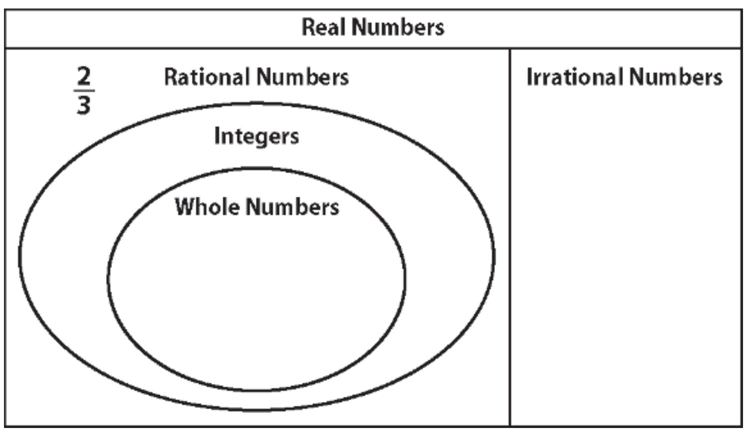
Place each of the given numbers in the correct location on the Venn diagram. The first one is done for you.

11. $\frac{2}{3}$

12. –99

13. $\frac{10}{11}$

14. 1,000



Name ______________________________ Date ______________ Class______________

LESSON 1-2

Sets of Real Numbers

Reteach

Numbers can be organized into groups. Each number can be placed into one or more of the groups.

Real numbers include all rational and irrational numbers. All of the numbers that we use in everyday life are real numbers.

- If a real number can be written as a fraction, it is a **rational number**. If it cannot be written as a fraction, it is an **irrational number**.
- If a rational number is a whole number, or the opposite of a whole number, then it is an **integer**.
- If an integer is positive or 0, then it is a **whole number**.

You can use these facts to categorize any number.

A. What kind of number is 10?

Is it a real number? *Yes.*

Is it a rational number? Can it be written as a fraction? *Yes*: $\frac{10}{1}$

Is it an integer? Is it a whole number or the opposite of a whole number? *Yes.*

Is it a whole number? *Yes.*

So 10 is a real number, a rational number, an integer, and a whole number.

B. What kind of number is $\sqrt{\frac{9}{3}}$?

Is it a real number? *Yes.*

Is it a rational number? Can it be written as a fraction? *No.* $\frac{9}{3}$ *simplifies to 3. If you try to find the square root of 3, you will get a decimal answer that goes on forever but does not repeat: 1.7320508… This cannot be written as a fraction.*

So $\sqrt{\frac{9}{3}}$ is a real, irrational number.

Answer each question to identify the categories the given number belongs to.

$\sqrt{16}$

1. Is it a real number? ______________
2. Is it a rational number? Can it be written as a fraction? ______________
3. Is it an integer? Is it a whole number or the opposite of a whole number? ______________
4. Is it a whole number? ______________
5. List all of the categories $\sqrt{16}$ belongs to.

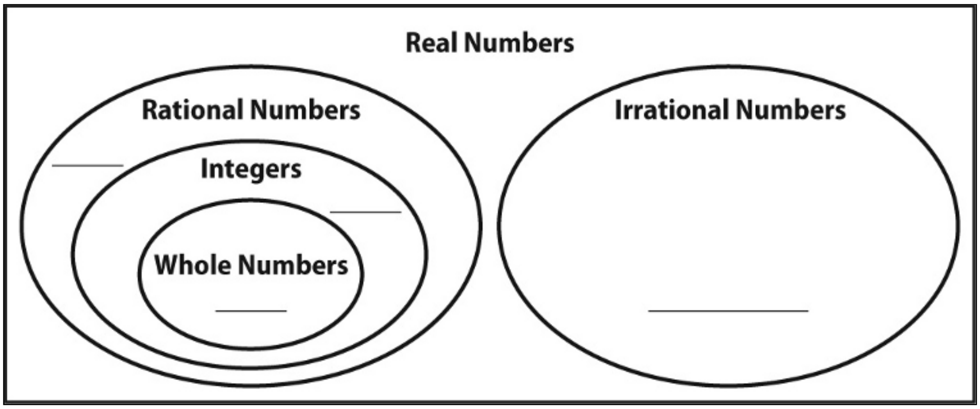
____

Name ______________________________________ Date _________________ Class_________________

LESSON 1-2

Sets of Real Numbers

Reading Strategies: Use a Venn Diagram



1. A real number is a ______________ or an ______________ number.

2. A rational number can be written as a ______________ or a ______________.

3. Both ______________ and ______________ decimals are rational numbers.

4. A set of integers is the set of ______________ and ______________ whole numbers and zero.

5. The whole numbers are the set of ______________ numbers and zero.

6. Place each number on the proper line on the Venn diagram.
   a. –5 b. 0.34 c. 11 d. π

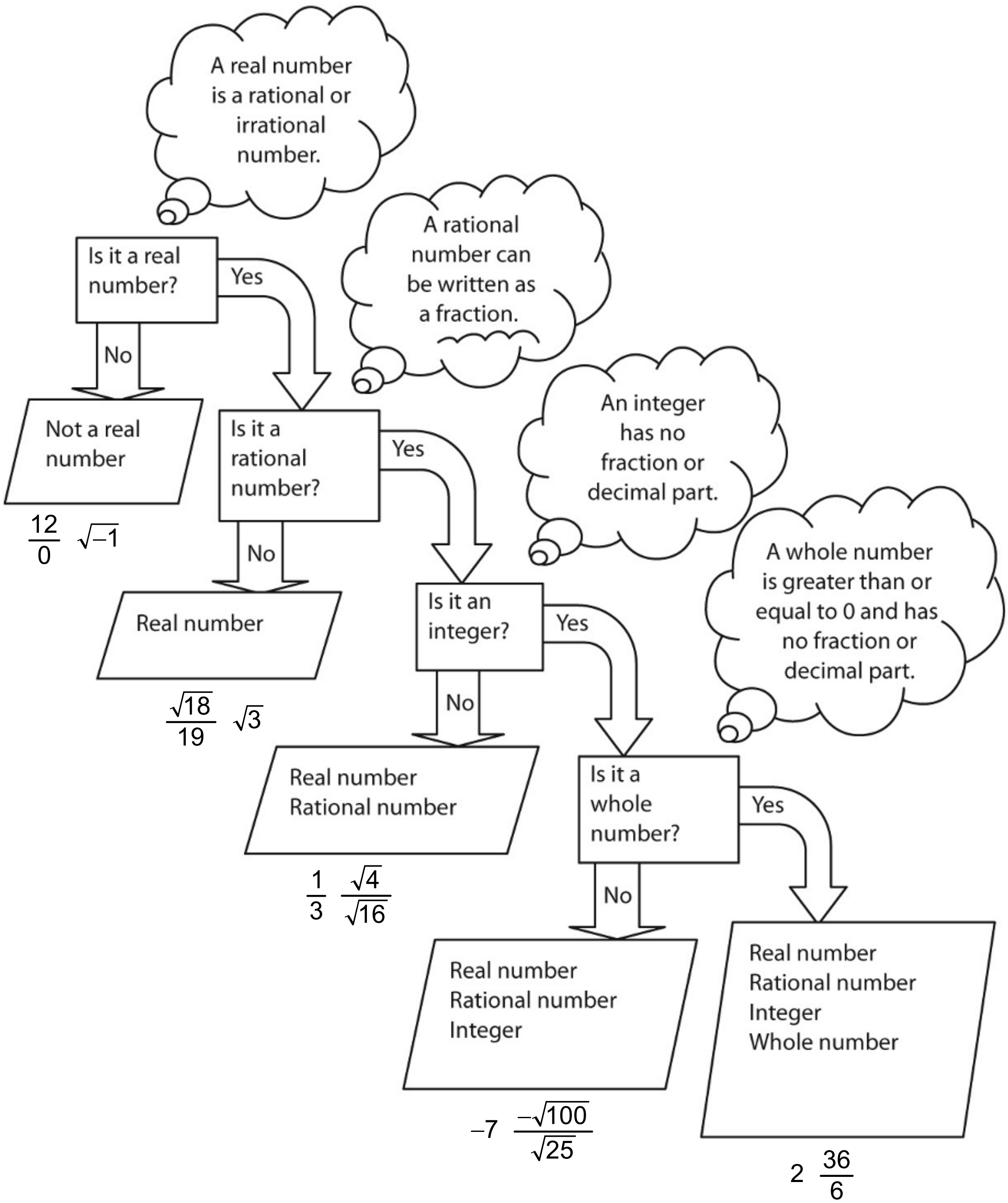
Name ______________________________________ Date _________________ Class_________________

LESSON 1-2

Sets of Real Numbers

Success for English Learners

Problem 1



Classify each number. Use the flowchart to help you.

1. $\sqrt{15}$ __________ 2. $\frac{3}{0}$ ____________ 3. $\sqrt{\frac{1}{9}}$ __________ 4. -13 __________

_______________ _______________ _______________ _______________

Name ______________________ Date ______________ Class______________

LESSON 1-3

Ordering Real Numbers

Practice and Problem Solving: A/B

Compare. Write <, >, or = .

1. $\sqrt{5} + 3$ ◯ $\sqrt{5} + 4$
2. $\sqrt{6} + 13$ ◯ $\sqrt{10} + 13$
3. $\sqrt{7} + 4$ ◯ $5 + \sqrt{6}$
4. $8 + \sqrt{2}$ ◯ $\sqrt{8} + 2$
5. $3 + \sqrt{3}$ ◯ $\sqrt{13} - 7$
6. $11 - \sqrt{3}$ ◯ $5 - \sqrt{3}$

Use the table to answer the questions.

7. List the butterflies in order from greatest to least wingspan.

____

____

____

____

Butterfly	Wingspan (in.)
Great white	3.75
Large orange sulphur	$3\frac{3}{8}$
Apricot sulphur	2.625
White-angled sulphur	3.5

8. The pink-spotted swallowtail's wingspan can measure $3\frac{5}{16}$ inches.

Between which two butterflies should the pink-spotted swallowtail be in your list from question 7?

____

Order each group of numbers from least to greatest.

9. $\sqrt{8}$, 2, $\frac{\sqrt{7}}{2}$

____

10. $\sqrt{12}$, π, 3.5

____

11. $\sqrt{26}$, –20, 13.5, $\sqrt{35}$

____

12. $\sqrt{6}$, –5.25, $\frac{3}{2}$, 5

____

Solve.

13. Four people have used different methods to find the height of a wall. Their results are shown in the table. Order their measurements from greatest to least. $\pi \approx 3.14$

Wall Height (m)			
Allie	Byron	Justin	Rosa
$\sqrt{12} - 1$	$\frac{5}{2}$	2.25	$1 + \frac{\pi}{2}$

____

Name ____ Date ________________ Class________________

LESSON 1-3

Ordering Real Numbers

Practice and Problem Solving: C

1. Order $4.\overline{6}$, $\sqrt{13} + 1$, and $2\pi - 1.68$ from least to greatest. Use $\pi \approx 3.14$.

   a. From least to greatest, the numbers are:

   ____

   b. Would the order change if you used $\pi \approx \frac{22}{7}$? Explain.

   ____

2. Four people are using different methods to measure the width of shelves to be installed in a closet using 3.5-centimeter brackets. Their results are shown in the table.

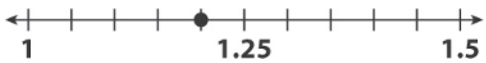
Shelf Width (m)			
Allie	**Byron**	**Justin**	**Rosa**
$\sqrt{12} - 2.2$	$\frac{\sqrt{23}}{2} - 1$	1.18	$1 + \frac{\pi}{9}$

   a. Order their measurements from greatest to least.

   ____

   b. The width of the closet, 1.2 meters, is shown on the number line. Graph the four measurements shown in the table.

   ____



   c. Whose shelf or shelves would be suitable to use in the closet? Explain.

   ____

   ____

   ____

Name ______________________________ Date ______________ Class______________

LESSON 1-3

Ordering Real Numbers

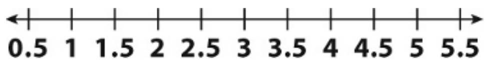
Practice and Problem Solving: D

Compare. Write <, >, or = . The first one is done for you.

1. $\sqrt{2} + 1$ < $\sqrt{2} + 8$
2. $\sqrt{2} + 5$ ◯ $\sqrt{2} + 3$
3. $\sqrt{3} + 5$ ◯ $5 + \sqrt{6}$
4. $8 + \sqrt{2}$ ◯ $\sqrt{8} + 2$
5. $3 + \sqrt{3}$ ◯ $\sqrt{7} - 3$
6. $5 - \sqrt{3}$ ◯ $-\sqrt{3} + 5$

Graph the numbers on the number line. Then order them from least to greatest.

7. $\sqrt{2}$, π, 4.5



From least to greatest, the numbers are ______, _____, and _____.

Order the numbers from least to greatest. The first one is done for you.

8. 2, $\frac{\sqrt{2}}{2}$, –10

   –10, $\frac{\sqrt{2}}{2}$, **2**
   ____

9. 7, π, $\sqrt{3}$

   ____

10. $\sqrt{8}$, –4, 1.5

    ____

11. $\sqrt{6}$, –5.5, $\frac{3}{2}$

    ____

Solve.

12. Four people have measured the height of a wall using different methods. Their results are shown in the table. Order their measurements from least to greatest.

Wall Height (m)			
Allie	**Byron**	**Justin**	**Rosa**
$\sqrt{8}$	$\frac{5}{2}$	2.6	$1 + \sqrt{3}$

____

Name ______________________ Date ____________ Class____________

LESSON 1-3

Ordering Real Numbers

Reteach

Compare and order real numbers from least to greatest.

Order $\sqrt{22}$, $\pi + 1$, and $4\frac{1}{2}$ from least to greatest.

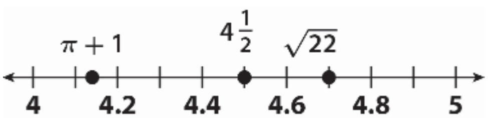
You can use a calculator to approximate irrational numbers.

$\sqrt{22} \approx 4.69$

You know that $\pi \approx 3.14$, so you can find the approximate value of $\pi + 1$.

$\pi + 1 \approx 3.14 + 1 \approx 4.14$

Plot $\sqrt{22}$, $\pi + 1$, and $4\frac{1}{2}$ on a number line.



On a number line, the values of numbers increase as you move from left to right. So, to order these numbers from least to greatest, list them from left to right.

$\pi + 1$, $4\frac{1}{2}$, and $\sqrt{22}$

Order each group of numbers from least to greatest.

1. $4, \pi, \sqrt{8}$

____

2. $5, \frac{17}{3}, \pi + 2$

____

3. $\sqrt{2}$, 1.7, –2

____

4. 2.5, $\sqrt{5}$, $\frac{3}{2}$

____

5. 3.7, $\sqrt{13}$, $\pi + 1$

____

6. $\frac{5}{4}$, $\pi - 2$, $\frac{\sqrt{5}}{2}$

____

Name ______________________ Date ______________ Class______________

LESSON 1-3

Ordering Real Numbers

Reading Strategies: Connect Words with Symbols

To compare real numbers, you can use the symbols $<$, $>$, and $=$.

To approximate irrational numbers, you can use the symbol $\approx$.

The symbol $<$ means "less than."

$\frac{1}{2} < 2$ ⟵ Read as "$\frac{1}{2}$ is less than 2."

The symbol $>$ means "greater than":

$\sqrt{6} > \sqrt{5}$ ⟵ Read as "The square root of 6 is greater than the square root of 5."

The symbol $=$ means "equal to":

$\sqrt{16} = 4$ ⟵ Read as
"The square root of 16 is equal to 4" OR
"The square root of 16 equals 4."

The sign $\approx$ means "approximately equal to":

$\pi \approx 3.14$ ⟵ Read as
"π is approximately equal to 3.14." OR
"π is approximately 3.14."

Write in words.

1. $\sqrt{13} < 4$

   ____

2. $0.501 \approx \frac{1}{2}$

   ____

3. $\sqrt{25} = 5$

   ____

4. $\pi + 1 > \frac{2}{3}$

   ____

Write using symbols.

5. Eighteen-halves is equal to nine. ______________________

6. 5.17 is greater than the square root of twenty-three.

   ____

7. Two-thirds is less than pi. ________________

Name ____________________ Date ______________ Class______________

LESSON 1-3

Ordering Real Numbers

Success for English Learners

Problem 1

Compare. Write <, >, or =.

Find approximate values for $\sqrt{5}$ and $\sqrt{2}$. Use a calculator.

$\sqrt{5} + 2 \bigcirc 5 + \sqrt{2}$

$\sqrt{5} \approx 2.2$ $\sqrt{2} \approx 1.4$

Substitute. $2.2 + 2 \bigcirc 5 + 1.4$

Add. $4.2 \bigcirc 6.4$

$4.2 < 6.4$, so $\sqrt{5} + 2 < 5 + \sqrt{2}$.

Problem 2

Order $\sqrt{7}$, $\pi - 1$, and 2.5 from least to greatest.

Find approximate values for $\sqrt{7}$ and $\pi - 1$.

$\sqrt{7} \approx 2.65$ $\pi - 1 \approx 3.14 - 1$

≈ 2.14

Plot the three values on a number line.

least greatest

From least to greatest, the numbers are $\pi - 1$, 2.5, and $\sqrt{7}$

1. Compare. Write <, >, or =.

   $\sqrt{13} + 8 \bigcirc \sqrt{8} + 13$

2. Order $\sqrt{19}$, $\pi + 1$, and 4.4 from least to greatest. ______________

3. Name a situation in which it would be very important to know the order of a series of numbers.

____

Name ____________________ Date __________ Class__________

MODULE 1

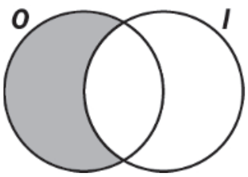
Real Numbers

Challenge

Venn Diagrams

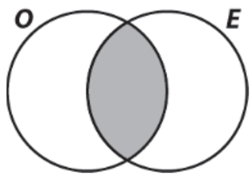
Diagrams using circles can show relationships between classes or sets. These diagrams are named after the English mathematician John Venn who introduced them.

Here are some examples using integers, even numbers, odd numbers, and primes. Remember that just one prime number, 2, is even. A shaded region is empty. A region marked *x* has at least one member.



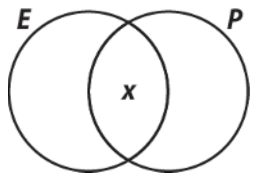
All odd numbers are integers.

All *O* is *I*.



No odd numbers are even.

No *O* is *E*.

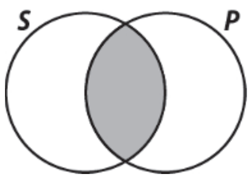


Some even numbers are prime.

Some *E* is *P*.

Describe each diagram using both words and letters. Set *S* is the square numbers.

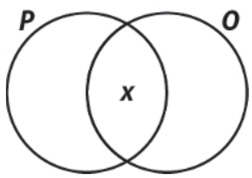
1.



____

____

2.



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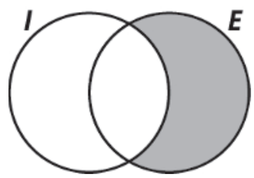
3.



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____

Draw a Venn diagram for each statement.

4. Some square numbers are odd.

____

5. No prime numbers are squares.

____

6. All square numbers are integers.

____

7. Some odd numbers are not prime.

____

Name ______________________________ Date ______________ Class______________

LESSON 2-1

Integer Exponents

Practice and Problem Solving: A/B

Find the value of each power.

1. $5^3 =$ ____________
2. $7^{-2} =$ ____________
3. $51^1 =$ ____________
4. $3^{-4} =$ ____________
5. $1^{12} =$ ____________
6. $64^0 =$ ____________
7. $4^{-3} =$ ____________
8. $4^3 =$ ____________
9. $10^5 =$ ____________

Find the missing exponent.

10. $n^3 = n^{\boxed{}} \bullet n^{-3}$

11. $\dfrac{a^{\boxed{}}}{a^2} = a^4$

12. $(r^4)^{\boxed{}} = r^{12}$

Simplify each expression.

13. $(9 - 3)^2 - (5 \bullet 4)^0 =$ ____________
14. $(2 + 3)^5 \div (5^2)^2 =$ ____________
15. $4^2 \div (6 - 2)^4 =$ ____________
16. $[(1 + 7)^2]^2 \bullet (12^2)^0 =$ ____________

Use the description below to complete Exercises 17–20.

A shipping company makes a display to show how many cubes can fit into a large box. Each cube has sides of 2 inches. The large box has sides of 10 inches.

17. Use exponents to express the volume of each cube and the large box.

    Volume of cube = ____________ Volume of large box = ____________

18. Find how many cubes will fit in the box. ____________________

19. Suppose the shipping company were packing balls with a diameter of 2 inches instead of cubes. Would the large box hold more balls or fewer balls than boxes? Explain your answer.

    ____

    ____

    ____

20. Suppose the size of each cube is doubled and the size of the large box is doubled. How many of these new cubes will fit in that new large box? Explain how you found your answer.

    ____

Name ______________________ Date ____________ Class____________

LESSON 2-1

Integer Exponents

Practice and Problem Solving: C

Simplify each expression.

1. $(7 - 3)^2 \bullet (6 - 2)^3 =$ ______________
2. $(7 - 3)^2 \div (6 - 2)^3 =$ ______________
3. $(2 \bullet 5^3) \div (9 - 4)^4 =$ ______________
4. $[(3 + 7)^2]^2 \bullet (10^2)^0 =$ ______________
5. $(3 \bullet 4)^2 \div (6 \bullet 2)^4 =$ ______________
6. $[(2^2)^2]^2 \bullet 2^3 =$ ______________

Answer each question.

7. Andrea quickly gave the answer to the problem below. Can you do the same? Explain how you found your answer.

   Find the value of $a^n \bullet a^{n-1} \bullet a^{n-2} \bullet a^{n-3} \bullet a^{n-4} \bullet a^{n-5} \bullet a^{n-6}$ when $a = 2$ and $n = 3$.

   ____

   ____

For each experiment, make a prediction first. Then complete the given table. Finally, try the experiment and see if your prediction is correct.

Experiment 1: Fold a piece of paper in half over and over again to make smaller and smaller rectangles.

8. Predict the maximum number of small rectangles you can make before

   you cannot fold the paper any further. ______________________

9.

Number of Folds	0	1	2	3	4	5	6	7	8	9	10
Number of Rectangles	2^0, 1	2^1, 2									

10. Do the experiment. How many rectangles could you make? ______________________

Experiment 2: Cut a piece of paper in half. Make a single pile of the pieces. Cut the pile in half. Continue making a single pile of the pieces and cutting the pile in half.

11. Predict the maximum number of pieces you can make before you cannot cut the paper any further. ______________________

12. Do the experiment. How many pieces could you make? ______________________

Name ______________________ Date ______________ Class______________

LESSON 2-1

Integer Exponents

Practice and Problem Solving: D

Write each expression without exponents. Then find the value. The first one is done for you.

1. $4^{-4} = \mathbf{\dfrac{1}{4 \times 4 \times 4 \times 4} = \dfrac{1}{256}}$

2. $6^2 =$ ______________________

3. $3^5 =$ ______________________

4. $24^0 =$ ______________________

5. $7^{-2} =$ ______________________

6. $10^5 =$ ______________________

Simplify each expression. Show your work. The first is done for you.

7. $\mathbf{\dfrac{(3 \cdot 2)^6}{(7-1)^4} = \dfrac{6^6}{6^4} = \dfrac{6^6}{6^4}}$

$\mathbf{= 6^{6-4} = 6^2}$

$\mathbf{= 36}$

8. $(3)^2 \bullet (3^1)$

____

____

____

9. $4^2 \bullet 4^3$

____

____

____

10. $(4^2)^3$

____

____

____

11. $(4 - 3)^2 \bullet (5 \bullet 4)^0$

____

____

____

12. $(2 + 3)^5 \div (5^2)^2$

____

____

____

Answer the question.

13. Find the value of $(2^2)^3$. Then find the value of $(2^3)^2$. What is true about the results? Explain why.

____

____

____

Name ______________________ Date ______________ Class ______________

LESSON 2-1

Integer Exponents

Reteach

A positive exponent tells you how many times to multiply the base as a factor. A negative exponent tells you how many times to divide by the base. Any number to the 0 power is equal to 1.

$4^2 = 4 \bullet 4 = 16$ $\quad 4^5 = 4 \bullet 4 \bullet 4 \bullet 4 \bullet 4 = 1024$ $\quad a^3 = a \bullet a \bullet a$

$4^{-2} = \frac{1}{4^2} = \frac{1}{4 \bullet 4} = \frac{1}{16}$ $\quad 4^{-5} = \frac{1}{4^5} = \frac{1}{4 \bullet 4 \bullet 4 \bullet 4 \bullet 4} = \frac{1}{1024}$ $\quad a^{-3} = \frac{1}{a^3} = \frac{1}{a \bullet a \bullet a}$

When you work with integers, certain properties are always true. With integer exponents, there are also certain properties that are always true.

When the bases are the same and you multiply, you add exponents.

$$\underbrace{2^2}_{2 \bullet 2} \bullet \underbrace{2^4}_{2 \bullet 2 \bullet 2 \bullet 2} = 2^{2+4} = 2^6 \qquad a^m \bullet a^n = a^{m+n}$$

When the bases are the same and you divide, you subtract exponents.

$$\frac{2^5}{2^3} = 2^{5-3} \qquad \frac{a^m}{a^n} = a^{m-n}$$

$$\frac{2 \bullet 2 \bullet \cancel{2} \bullet \cancel{2} \bullet \cancel{2}}{\cancel{2} \bullet \cancel{2} \bullet \cancel{2}} = 2^2$$

When you raise a power to a power, you multiply.

$$(2^3)^2 = 2^{3 \bullet 2} \qquad (a^m)^n = a^{m \bullet n}$$

$$(2 \bullet 2 \bullet 2)^2$$

$$(2 \bullet 2 \bullet 2) \bullet (2 \bullet 2 \bullet 2) = 2^6$$

Tell whether you will add, subtract, or multiply the exponents. Then simplify by finding the value of the expression.

1. $\frac{3^6}{3^3} \rightarrow$ ______________________

2. $8^2 \bullet 8^{-3} \rightarrow$ ______________________

3. $(3^2)^3 \rightarrow$ ______________________

4. $5^3 \bullet 5^1 \rightarrow$ ______________________

5. $\frac{4^2}{4^4} \rightarrow$ ______________________

6. $(6^2)^2 \rightarrow$ ______________________

Name ________________________ Date ______________ Class______________

LESSON
2-1

Integer Exponents

Reading Strategies: Using Patterns

You can use patterns to help evaluate powers.

Look at the patterns in each column. As you move down the column, you will note that the products are getting smaller. That is because there is one less factor when the powers are positive and one more factor when the powers are negative.

Column 1	Column 2	Column 3
$2^3 = 8$	$3^3 = 27$	$4^3 = 64$
$2^2 = 4$	$3^2 = 9$	$4^2 = 16$
$2^1 = 2$	$3^1 = 3$	$4^1 = 4$
$2^0 = 1$	$3^0 = 1$	$4^0 = 1$
$2^{-1} = \frac{1}{2}$	$3^{-1} = \frac{1}{3}$	$4^{-1} = \frac{1}{4}$
$2^{-2} = \frac{1}{4}$	$3^{-2} = \frac{1}{9}$	$4^{-2} = \frac{1}{16}$

Use the table to answer each question.

1. Describe the pattern of the exponents in each column.

____

2. What is the base of column 2? ____________________
3. In column 2, what is the product divided by each time to get the product in the cell below? ____________________
4. What is the base of column 3? ____________________
5. In column 3, what is the product divided by each time to get the product in the cell below? ____________________

Complete the table, using the table above as a guide.

6.

Column 1	Column 2	Column 3
$5^3 = 125$	$6^3 = 216$	$10^3 = 1000$
$5^2 = 25$	$6^2 = 36$	$10^2 = 100$

Name ______________________ Date ____________ Class____________

LESSON 2-1

Integer Exponents

Success for English Learners

The set of integers is the set of whole numbers and their opposites, such as 3, 2, 1, 0, –1, –2, and –3. Integer exponents are powers of a number where the power is a whole number or its opposite.

Problem 1

$4^2 = 4 \bullet 4 = 16$ $\quad$ $4^5 = 4 \bullet 4 \bullet 4 \bullet 4 \bullet 4 = 1024$ $\quad$ $a^3 = a \bullet a \bullet a$

$4^{-2} = \frac{1}{4^2} = \frac{1}{4 \bullet 4} = \frac{1}{16}$ $\quad$ $4^{-5} = \frac{1}{4^5} = \frac{1}{4 \bullet 4 \bullet 4 \bullet 4 \bullet 4} = \frac{1}{1024}$ $\quad$ $a^{-3} = \frac{1}{a^3} = \frac{1}{a \bullet a \bullet a}$

Problem 2

When you work with integers, certain properties are always true. With integer exponents, there are also certain properties that are always true.

Use properties of exponents to simplify each expression.

$$\underbrace{2 \bullet 2}_{2^2} \bullet \underbrace{2 \bullet 2 \bullet 2 \bullet 2}_{2^4} = 2^{2+4} = 2^6 \qquad a^m \bullet a^n = a^{m+n}$$

$$\frac{2^5}{2^3} = 2^{5-3}$$

$$\frac{2 \bullet 2 \bullet \cancel{2} \bullet \cancel{2} \bullet \cancel{2}}{\cancel{2} \bullet \cancel{2} \bullet \cancel{2}} = 2^2 \qquad \frac{a^m}{a^n} = a^{m-n}$$

$$(2^3)^2 = 2^{3 \bullet 2}$$

$$(2 \bullet 2 \bullet 2)^2 \qquad (a^m)^n = a^{m \bullet n}$$

$$(2 \bullet 2 \bullet 2) \bullet (2 \bullet 2 \bullet 2) = 2^6$$

Complete.

1. Explain in your own words what a negative exponent means.

____

____

Use properties of exponents to simplify each expression.

2. $\frac{3^6}{3^4} =$ ____________ 3. $4^2 \bullet 4^1 =$ ____________ 4. $(x^5)^4 =$ ____________

5. $(4^2)^3 =$ ____________ 6. $12^3 \bullet 12^{-2} =$ ____________ 7. $z^6 \bullet z^6 =$ ____________

Name ______________________ Date ______________ Class______________

LESSON 2-2

Scientific Notation with Positive Powers of 10

Practice and Problem Solving: A/B

Write each number as a power of 10.

1. 100 ________
2. 10,000 ________
3. 100,000 ________
4. 10,000,000 ________
5. 1,000,000 ________
6. 1000 ________
7. 1,000,000,000 ________
8. 1 ________

Write each power of ten in standard notation.

9. 10^3 ________
10. 10^5 ________
11. 10 ________
12. 10^6 ________
13. 10^2 ________
14. 10^0 ________
15. 10^4 ________
16. 10^7 ________

Write each number in scientific notation.

17. 2500 ________
18. 300 ________
19. 47,300 ________
20. 24 ________
21. 14,565 ________
22. 7001 ________
23. 19,050,000 ________
24. 33 ________

Write each number in standard notation.

25. 6×10^3 ________
26. 4.5×10^2 ________
27. 7×10^7 ________
28. 1.05×10^4 ________
29. 3.052×10^3 ________
30. 5×10^0 ________
31. 9.87×10^1 ________
32. 5.43×10^1 ________

Solve.

33. The average distance of the Moon from Earth is about 384,400 kilometers. Write this number in scientific notation.

____

34. The radius of Earth is about 6.38×10^3 kilometers. Write this distance in standard notation.

____

Name ______________________ Date ______________ Class______________

LESSON 2-2

Scientific Notation with Positive Powers of 10

Practice and Problem Solving: C

Write each pair of numbers in standard notation. Use the symbols >, <, or = to compare them. Show your work.

1. 2.5×10^3 ____ 2.5×10^6

____

2. 5×10^6 ____ 2.5×10^6

____

3. 3×10^0____ 1×10^1

____

4. 4.025×10^3 ____ 1.025×10^4

____

Write each pair of numbers in scientific notation. Write the numbers in scientific notation on the correct side of the comparison symbol.

5. 1200; 450

__________ < __________

6. 230,000; 32,000

__________ > __________

Write the numbers from least to greatest.

7. 3.25×10^6, 5.32×10^5, 2.35×10^6, 5.32×10^6, 3.25×10^5, 2.35×10^5

____

8. 5×10^0, 1×10^1, 0×10^0, 1×10^0, 5×10^1

____

Use the fact that 1 meter equals 10^3 millimeters and 1 centimeter equals 10^1 millimeters to label each of these statements as true or false. Show your work.

9. 1×10^3 m > 1×10^5 cm
   True or false?

____

10. 9×10^1 m = 9×10^1 mm
    True or false?

____

Solve.

11. An athletic stadium has a capacity of 1.5×10^4 fans. If 9×10^3 fans buy advance tickets to an event at the stadium, how many tickets will be available at the box office on the day of the event? Show your work by writing the numbers in standard notation.

____

12. A town's most popular drive-in restaurant has 2,500 followers on a social networking website. The town's high school athletic program has 1.5×10^4 followers on the same website. Which is more popular according to this data, the drive-in or the athletic program? Show your work by writing the numbers in standard notation.

____

Name ________________________ Date ______________ Class______________

LESSON 2-2

Scientific Notation with Positive Powers of 10

Practice and Problem Solving: D

Write each product in standard form. The first one is done for you.

1. $10 \times 10 =$ **100**
2. $10 \times 10 \times 10 \times 10 \times 10 =$ ________
3. $10 \times 10 \times 10 \times 10 =$ ________
4. $10 \times 10 \times 10 =$ ________

Write each number as a product of tens. The first one is done for you.

5. $100{,}000 =$ **$10 \times 10 \times 10 \times 10 \times 10$**
6. $10{,}000{,}000 =$ ________
7. $10{,}000 =$ ________
8. $100{,}000{,}000{,}000 =$ ________

Write each number as a power of ten and an exponent. The first one is done for you.

9. $1000 =$ **10^3**
10. $10 =$ ________
11. $100{,}000 =$ ________

Write each power of ten in standard form. The first one is done for you.

12. 10^1 **10**
13. 10^3 ________
14. 10^4 ________
15. 10^9 ________
16. 10^5 ________
17. 10^0 ________

Write the exponent for the question mark. The first one is done for you.

18. $3600 = 3.6 \times 10^?$ **3**
19. $450 = 4.5 \times 10^?$ ____
20. $5{,}000{,}000 = 5 \times 10^?$ ____
21. $6 = 6 \times 10^?$ ____

Write each number in standard form. The first one is done for you.

22. $3.56 \times 10^3 =$ **3,560**
23. $9 \times 10^3 =$ ________
24. $6.875 \times 10^4 =$ ________
25. $4.005 \times 10^6 =$ ________

Solve.

26. The volume of a cube is 10 feet times 10 feet times 10 feet. Write this product as one number in standard form.

____

Name ______________________ Date ______________ Class______________

LESSON 2-2

Scientific Notation with Positive Powers of 10

Reteach

You can change a number from standard notation to scientific notation in 3 steps.

1. Place the decimal point between the first and second digits on the left to make a number between 1 and 10.
2. Count from the decimal point to the right of the last digit on the right.
3. Use the number of places counted in Step 2 as the power of ten.

Example

Write 125,000 in scientific notation.

1.25 — 1) The first and second digits to the left are 1 and 2, so place the decimal point between the two digits to make the number 1.25.

125,000 — 2) The last digit in 125,000 is 5 places to the right.

1.25×10^5 — 3) The power of 10 is 5.

You can change a number from scientific notation to standard notation in 3 steps.

1. Find the power of 10.
2. Count that number of places to the right.
3. Add zeros as needed.

Example

Write 5.96×10^4 in standard notation.

10^4 — 1) The power of 10 is 4.

5.9600 — 2) Move the decimal point 4 places to the right.

59,600 — 3) Add two zeros.

Complete to write each number in scientific notation.

1. 34,600

   The number between 1 and 10: ____

   The power of 10: ____

   The number in scientific notation:

   ____

2. 1,050,200

   The number between 1 and 10: ____

   The power of 10: ____

   The number in scientific notation:

   ____

Write each number in standard notation.

3. 1.057×10^3 ______________

4. 3×10^8 ______________

5. 5.24×10^5 ______________

Name ______________________ Date ______________ Class______________

LESSON 2-2

Scientific Notation with Positive Powers of 10

Reading Strategies: Follow a List of Steps

Lists can help you understand the steps of changing from standard notation to scientific notation.

Change a number from standard notation to scientific notation

A Locate the digit that is on the left end of the number. For example, if the number is 2350, the digit on the far left is "2."

B Place the decimal point *after* or *to the right* of that digit. For example, in the example 2350, moving the decimal makes the number "2.350". This gives a number between 1 and 10.

C Count places to the right from the new decimal point to the end of the number. How many is that? In the example, it is *three places* from the new decimal point to the right end of the number.

D Use the number of places as the *exponent* or *power* of ten after you write the number between 1 and 10, a times sign, and a "10." In this example, the "3" goes with the "10." This gives 2.350×10^3. After moving the decimal, zeros at the end of the number can be dropped, so 10^3 can be written as 2.35×10^3.

Fill in the steps in the list below each number as you write it in scientific notation.

1. 295

A: ______________

B: ______________

C: ______________

D: ______________

2. 10,500

A: ______________

B: ______________

C: ______________

D: ______________

3. 4,505,000

A: ______________

B: ______________

C: ______________

D: ______________

Change a number from scientific notation to standard notation

A Find the decimal point in the number between 1 and 10 in a number written in scientific notation. For example, in 4.56×10^7 the decimal is between the digits "4" and "5".

B Locate the exponent or power of 10. In the example 4.56×10^7 the power of 10 is "7."

C Starting at the decimal, count seven places to the right. If there are no numbers to be counted, write zeros. In the example 4.56×10^7, you would count the "5" and the "6" as two places, and add five zeros. This would give 45600000, or 45,600,000.

Fill in the steps below each number as you write it in standard notation.

4. 2.5×10^4

A: ______________

B: ______________

C: ______________

5. 7×10^5

A: ______________

B: ______________

C: ______________

6. 1.234×10^3

A: ______________

B: ______________

C: ______________

Name ______________________ Date ____________ Class____________

LESSON 2-2

Scientific Notation with Positive Powers of 10

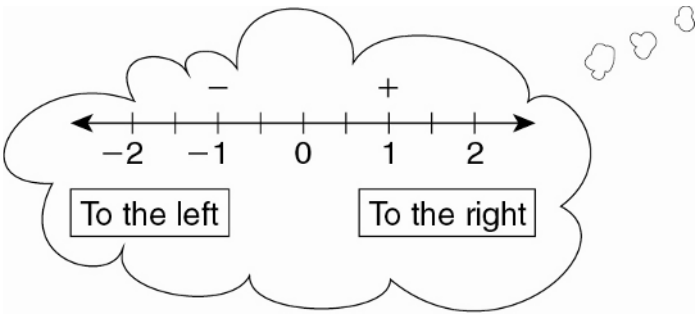
Success for English Learners

Problem 1

Write 3.12×10^9 in standard notation.

Which way should you move the decimal point?

Think about the number line.



The exponent 9 is positive, so the decimal point moves to the *right*.

So, 3.12×10^9 in standard notation is 3,120,000,000.

Problem 2

Write 7,505,000 in scientific notation.

7,505,000 ⟵ Move decimal point *six* places to the *left*.

When you move the decimal to the left, the exponent of 10 is positive.

So, 7,505,000 in scientific notation is 7.505×10^6.

1. Which number is greater, 3.28×10^5 or 3.28×10^3? Prove your answer by writing each number in standard notation.

____

2. Is 3×10^6 grams more likely to be the mass of a car or the mass of an eyelash? Explain.

____

____

3. Write 186,000 in scientific notation.

____

4. Write 4.56789×10^3 in standard form.

____

Name ______________________ Date ______________ Class______________

LESSON 2-3

Scientific Notation with Negative Powers of 10

Practice and Problem Solving: A/B

Write each number as a negative power of ten.

1. $\frac{1}{10^2}$ = ________
2. $\frac{1}{10^4}$ = ________
3. $\frac{1}{10^5}$ = ________
4. $\frac{1}{10^7}$ = ________
5. $\frac{1}{10^6}$ = ________
6. $\frac{1}{10^3}$ = ________
7. $\frac{1}{10^9}$ = ________
8. $\frac{1}{10^1}$ = ________

Write each power of ten in standard notation.

9. 10^{-3} = ________
10. 10^{-5} = ________
11. 10^{-1} = ________
12. 10^{-6} = ________
13. 10^{-2} = ________
14. 10^{-9} = ________
15. 10^{-4} = ________
16. 10^{-7} = ________

Write each number in scientific notation.

17. 0.025 ________
18. 0.3 ________
19. 0.000473 ________
20. 0.0024 ________
21. 0.000014565 ________
22. 0.70010 ________
23. 0.0190500 ________
24. 0.00330000 ________

Write each number in standard notation.

25. 6×10^{-3} ________
26. 4.5×10^{-2} ________
27. 7×10^{-7} ________
28. 1.05×10^{-6} ________
29. 3.052×10^{-8} ________
30. 5×10^{-1} ________
31. 9.87×10^{-4} ________
32. 5.43×10^{-5} ________

Solve.

33. An *E. coli* bacterium has a diameter of about 5×10^{-7} meter. Write this measurement as a decimal in standard notation.

____

34. A human hair has an average diameter of about 0.000017 meter. Write this measurement in scientific notation.

____

Name ______________________________ Date ______________ Class______________

LESSON 2-3

Scientific Notation with Negative Powers of 10

Practice and Problem Solving: C

Write each pair of numbers in standard notation. Use the symbols >, <, or = to compare them.

1. 5.2×10^{-3} ◯ 5.2×10^{-6}

____

2. 5×10^{-6} ◯ 2.5×10^{-5}

____

3. 3×10^{0} ◯ 1×10^{-1}

____

4. 5.02×10^{-3} ◯ 2.05×10^{-4}

____

Write each pair of numbers in scientific notation. Write the numbers in scientific notation on the correct side of the comparison symbol.

5. 0.0012; 0.45

__________ < __________

6. 0.0000023; 0.00032

__________ > __________

List the numbers in order from least to greatest.

7. 3.25×10^{-6}, 5.32×10^{-5}, 2.35×10^{-6}, 5.32×10^{-6}, 3.25×10^{-5}, 2.35×10^{-5}

____

8. 5×10^{0}, 1×10^{-1}, 0×10^{0}, 1×10^{0}, 5×10^{-1}

____

Identify whether each statement is true or false. Circle the correct answer. Show your work. (1 m = 10^3 mm; 1 cm = 10^1 mm)

9. 1×10^{-3} m $>$ 1×10^{-1} cm

True or false?

____

10. 7×10^{-1} cm $<$ 7×10^{-3} m

True or false?

____

11. 3.5×10^{-1} cm $=$ 3.5×10^{-3} m

True or false?

____

12. 9×10^{-1} mm $=$ 9×10^{-4} m

True or false?

____

Solve.

13. A test tube used in science class has a volume capacity of 9×10^{-3} liter. How many drops of a solution will it take to fill the test tube if each drop's volume is 3×10^{-5} liter? Write these numbers in standard notation and then calculate the answer.

____

14. A logic array on a semiconductor chip has a rectangular shape. Its length is 0.00025 meter and its width is 0.000125 meter. What is the logic array's area? Write these numbers in scientific notation.

____

Name ______________________ Date ____________ Class____________

LESSON 2-3

Scientific Notation with Negative Powers of 10

Practice and Problem Solving: D

Write each product in standard form. The first one is done for you.

1. $\frac{1}{10 \times 10} = \underline{\mathbf{\frac{1}{100}}}$

2. $\frac{1}{10 \times 10 \times 10 \times 10 \times 10} = $ ____________

3. $\frac{1}{10 \times 10 \times 10 \times 10} = $ ____________

4. $\frac{1}{10 \times 10 \times 10} = $ ____________

Write each number as a product of tens. The first one is done for you.

5. $\frac{1}{100{,}000} = \underline{\mathbf{\frac{1}{10 \times 10 \times 10 \times 10 \times 10}}}$

6. $\frac{1}{10{,}000{,}000} = $ ____________

7. $\frac{1}{10{,}000} = $ ____________

8. $\frac{1}{100{,}000{,}000{,}000} = $ ____________

Write each number as both a power of ten and a negative exponent. The first one is done for you.

9. $\frac{1}{1000} = \underline{\mathbf{\frac{1}{10^3} = 10^{-3}}}$

10. $\frac{1}{10} = $ ____________

11. $\frac{1}{100} = $ ____________

12. $\frac{1}{10{,}000} = $ ____________

Write in standard form. The first one is done for you.

13. $\frac{1}{10^1} = \underline{\mathbf{\frac{1}{10}}}$

14. $\frac{1}{10^3} = $ ____________

15. $\frac{1}{10^4} = $ ____________

16. $\frac{1}{10^9} = $ ____________

17. $\frac{1}{10^5} = $ ____________

18. $\frac{1}{10^{12}} = $ ____________

Identify the unknown exponent. The first one is done for you.

19. $0.00036 = 3.6 \times 10^?$ **–4**

20. $0.450 = 4.5 \times 10^?$ ____

21. $0.00000005 = 5 \times 10^?$ ____

22. $0.00600 = 6 \times 10^?$ ____

Write each number in standard form. The first one is done for you.

23. $3.56 \times 10^{-3} = $ **0.00356**

24. $9 \times 10^{-5} = $ ______________

25. $6.875 \times 10^{-4} = $ ______________

26. $4.005 \times 10^{-6} = $ ______________

Solve.

27. The volume of a box is found by multiplying its length, width, and height. The three sides are 0.5 foot, 0.75 foot, and 0.4 foot. Find the product. Write it in scientific notation.

____

Name ______________________ Date ______________ Class______________

LESSON 2-3

Scientific Notation with Negative Powers of 10

Reteach

You can convert a number from standard form to scientific notation in 3 steps.

1. Starting from the left, find the first non-zero digit. To the right of this digit is the new location of your decimal point.
2. Count the number of places you moved the decimal point. This number will be used in the exponent in the power of ten.
3. Since the original decimal value was less than 1, your power of ten must be negative. Place a negative sign in front of the exponent.

Example

Write 0.00496 in standard notation.

4.96	1) The first non-zero digit is 4, so move the decimal point to the right of the 4.
4.96×10^{3}	2) The decimal point moved 3 places, so the whole number in the power of ten is 3.
4.96×10^{-3}	3) Since 0.00496 is less than 1, the power of ten must be negative.

You can convert a number from scientific notation to standard form in 3 steps.

1. Find the power of ten.
2. If the exponent is negative, you must move the decimal point to the left. Move it the number of places indicated by the whole number in the exponent.
3. Insert a leading zero before the decimal point.

Example

Write 1.23×10^{-5} in standard notation.

10^{-5}	1) Find the power of ten.
.0000123	2) The exponent is –5, so move the decimal point 5 places to the left.
0.0000123	3) Insert a leading zero before the decimal point.

Write each number in scientific notation.

1. 0.0279 ____________
2. 0.00007100 ____________
3. 0.0000005060 ____________

Write each number in standard notation.

4. 2.350×10^{-4} ____________
5. 6.5×10^{-3} ____________
6. 7.07×10^{-5} ____________

Name ______________________ Date ______________ Class______________

LESSON 2-3

Scientific Notation with Negative Powers of 10

Reading Strategies: Use Graphic Aids

Change a number from standard notation to scientific notation

Change 0.0000003 to scientific notation.

A. What is the first non-zero digit? It is 3.

B. Move the decimal point until it is directly to the right of the 3.
0.0000003 ⟵ The decimal point moves 7 places *to the right*.

C. The decimal point moved 7 places to the *right*. So, the power of ten is 7, and it must be must be *negative*. The power of ten is –7.

D. So, the number in scientific notation is 3.0×10^{-7}

Fill in the steps below each number to write it in scientific notation.

1. 0.00123

First non-zero digit: ______________

Number of places from decimal: ____

Direction decimal point moves: _____

Power of 10: ___________________

Scientific notation: _______________

2. 0.00000567

First non-zero digit: ______________

Number of places from decimal: ____

Direction decimal point moves: _____

Power of 10: ___________________

Scientific notation: _______________

Change a number from scientific notation to standard notation

Change 2.5×10^{-4} to standard notation.

A. What is the power of 10? It is –4.

B. Since the power of 10 is negative, the decimal must move *left*.
0002.5 ⟵ Move the decimal point 4 places *to the left*.

C. So, the number in standard notation is 0.00025.

Fill in the steps below each number to write it in standard notation.

3. 6.7×10^{-8}

Power of 10: ___________________

Direction decimal point moves: _____

Number of places: _______________

Standard notation: _______________

4. 3.21×10^{-4}

Power of 10: ___________________

Direction decimal point moves: _____

Number of places: _______________

Standard notation: _______________

Name ______________________ Date ____________ Class ____________

LESSON 2-3

Scientific Notation with Negative Powers of 10

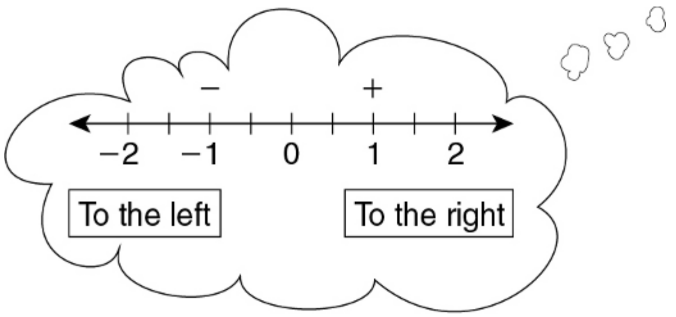
Success for English Learners

Problem 1

Write 5.43×10^{-6} in standard notation.

Which way should you move the decimal point?

Think about the number line.



The exponent (–6) is negative, so the decimal point moves to the *left*.

So, 5.43×10^{-6} in standard notation is 0.00000543.

Problem 2

Write 0.00000456 in scientific notation.

0.00000456 ⟵ Move decimal point *six* places to the *right*.

When you move the decimal to the right, the exponent is negative.

So, 0.00000456 in scientific notation is 4.56×10^{-6}.

1. Which number is greater, 5.75×10^{-3} or 5.75×10^{-4}? Prove your answer by writing each number in standard notation.

____

2. Is 3×10^{-7} grams more likely to be the mass of a bicycle or the mass of a hair? Explain.

____

____

3. Write 0.000493 in scientific notation.

____

4. Write 3.21×10^{-5} in standard form.

____

Name ________________ Date ________ Class________

LESSON 2-4

Operations with Scientific Notation

Practice and Problem Solving: A/B

Add or subtract. Write your answer in scientific notation.

1. $6.4 \times 10^3 + 1.4 \times 10^4 + 7.5 \times 10^3$

____

2. $4.2 \times 10^6 - 1.2 \times 10^5 - 2.5 \times 10^5$

____

3. $3.3 \times 10^9 + 2.6 \times 10^9 + 7.7 \times 10^8$

____

4. $8.0 \times 10^4 - 3.4 \times 10^4 - 1.2 \times 10^3$

____

Multiply or divide. Write your answer in scientific notation.

5. $(3.2 \times 10^8)(1.3 \times 10^9) =$ ____________

6. $\dfrac{8.8 \times 10^7}{4.4 \times 10^4} =$ ____________

7. $(1.5 \times 10^6)(5.9 \times 10^4) =$ ____________

8. $\dfrac{1.44 \times 10^{10}}{2.4 \times 10^2} =$ ____________

Write each number using calculator notation.

9. $4.1 \times 10^4 =$ ____________

10. $9.4 \times 10^{-6} =$ ____________

Write each number using scientific notation.

11. 5.2E–6 = ____________

12. 8.3E+2 = ____________

Use the situation below to complete Exercises 13–16. Express each answer in scientific notation.

A runner tries to keep a consistent stride length in a marathon. But, the length will change during the race. A runner has a stride length of 5 feet for the first half of the race and a stride length of 4.5 feet for the second half.

13. A marathon is 26 miles 385 yards long. That is about 1.4×10^5 feet. How many feet long is half a marathon?

____

14. How many strides would it take to finish the first half of the marathon?

____

15. How many strides would it take to finish the second half of the marathon?

____

Hint: Write 5 ft as 5.0×10^0 and 4.5 feet as 4.5×10^0.

16. How many strides would it take the runner to complete marathon? Express your answer in both scientific notation and standard notation.

____

Name ______________________ Date ______________ Class______________

LESSON 2-4

Operations with Scientific Notation

Practice and Problem Solving: C

Add or subtract. Write your answer in scientific notation.

1. $2.4 \times 10^2 + 3.4 \times 10^4 + 1.5 \times 10^3$

____

2. $6.2 \times 10^4 - 3.4 \times 10^2 - 7.5 \times 10^3$

____

3. $8.3 \times 10^5 + 1.6 \times 10^7 + 6.7 \times 10^4$

____

4. $8.0 \times 10^3 - 0.8 \times 10^3 - 1.2 \times 10^2$

____

Multiply or divide. Write your answer in scientific notation.

5. $(5.2 \times 10^8)(4.8 \times 10^4) =$ ______________

6. $\dfrac{9.8 \times 10^7}{1.4 \times 10^{-5}} =$ ______________

7. $(8.5 \times 10^2)(3.4 \times 10^{-5}) =$ ______________

8. $\dfrac{1.702 \times 10^5}{7.4 \times 10^8} =$ ______________

Use the information below to complete Exercises 9–13.

A 60-watt light bulb uses 60 watt hours of electricity in 1 hour. Suppose everyone in the United States left one unneeded 60 watt light bulb on for one hour every day for a year.

9. Electricity is billed in kilowatt hours. So 60 watt hours is equal to sixty divided by one thousand. Express the electricity used by a 60-watt light bulb in one hour in kilowatt hours in scientific notation.

____

10. Express the number of days in a year in scientific notation.

____

11. There are about 315,000,000 people in the United States. Write that number in scientific notation.

____

12. Now find how many kilowatt hours of electricity would be wasted if every person in the United States left on one unneeded 60-watt light bulb one hour a day for a whole year. Express your answer in both scientific notation and standard notation.

____

13. The average household uses about 15,000 kilowatt hours per year. How many households could use that wasted electricity from item 12 and have light for a year? Express your answer in standard notation.

____

Name ____ Date __________________ Class__________________

LESSON 2-4

Operations with Scientific Notation

Practice and Problem Solving: D

Add or subtract. Write your answer in scientific notation. The first one is done for you.

1. $2.4 \times 10^2 + 3.3 \times 10^4 + 7.2 \times 10^3$

   $240 + 33{,}000 + 7200 = 40{,}440$

   $= 4.044 \times 10^4$

2. $1.2 \times 10^4 - 1.5 \times 10^3 - 2.2 \times 10^2$

   ____

   ____

3. $7.3 \times 10^5 + 1.6 \times 10^6 + 4.7 \times 10^5$

   ____

   ____

4. $8.2 \times 10^4 - 2.4 \times 10^4 - 1.5 \times 10^3$

   ____

   ____

Multiply or divide. Write your answer in scientific notation. The first one is done for you.

5. $(3.2 \times 10^3)(6.4 \times 10^9) =$ **$(3.2 \times 6.4) \times (10^3 \times 10^9)$**

   $= 20.48 \times 10^{3+9}$

   $= 20.48 \times 10^{12}$

   $= 2.048 \times 10^{13}$

6. $\dfrac{9.6 \times 10^5}{5 \times 10^4} =$

   ____

   ____

   ____

7. $(2.5 \times 10^4)(4.1 \times 10^4) =$ ________

   ____

   ____

   ____

8. $\dfrac{6.4 \times 10^{10}}{3.2 \times 10^2} =$ ________

   ____

   ____

   ____

Write each number using calculator notation. The first one is done for you.

9.	Scientific notation	7.1×10^5		4.4×10^{-3}		
10.	Calculator notation	**7.1E+5**	3.3E–3			6.9E+5

Answer the questions.

11. How do you write one million in scientific notation? ________________________

12. A day is 8.64×10^4 seconds long. Write and solve an expression to find how many days are in one million seconds. Give your answer in standard form.

____

Name ______________________ Date ______________ Class______________

LESSON 2-4

Operations with Scientific Notation

Reteach

To add or subtract numbers written in scientific notation:

Check that the exponents of powers of 10 are the same.
If not, adjust the decimal numbers and the exponents.
Add or subtract the decimal numbers.
Write the sum or difference and the common power of 10 in scientific notation format.
Check whether the answer is in scientific notation.
If it is not, adjust the decimal and the exponent.

$(a \times 10^n) + (b \times 10^n) = (a + b) \times 10^n$

$(a \times 10^n) - (b \times 10^n) = (a - b) \times 10^n$

$(1.2 \times 10^5) - (9.5 \times 10^4)$

$(1.2 \times 10^5) - (0.95 \times 10^5)$ ← Adjust to get same exponent.

$(1.2 - 0.95) \times 10^5$

0.25×10^5 ← Not in scientific notation.

2.5×10^4 ← Answer

To multiply numbers written in scientific notation:

Multiply the decimal numbers.
Add the exponents in the powers of 10.
Check whether the answer is in scientific notation.
If it is not, adjust the decimal numbers and the exponent.

$(a \times 10^n) \times (b \times 10^m) = ab \times 10^{n+m}$

$(2.7 \times 10^8) \times (8.9 \times 10^4)$

$(2.7 \times 8.9) \times 10^{8+4}$

24.03×10^{12} ← Not in scientific notation.

2.403×10^{13} ← Answer

To divide numbers written in scientific notation:

Divide the decimal numbers.
Subtract the exponents in the powers of 10.
Check whether the answer is in scientific notation.
If it is not, adjust the decimal numbers and the exponent.

$(a \times 10^n) \div (b \times 10^m) = a \div b \times 10^{n-m}$

$(6.3 \times 10^7) \div (9.0 \times 10^3)$

$(6.3 \div 9.0) \times 10^{7-3}$

0.7×10^4 ← Not in scientific notation.

7.0×10^3 ← Answer

Compute. Write each answer in scientific notation.

1. $(2.21 \times 10^7) \div (3.4 \times 10^4)$ ______________
2. $(5.8 \times 10^6) - (4.3 \times 10^6)$ ______________
3. $(2.8 \times 10^3)(7.5 \times 10^4)$ ______________

Name ______________________________ Date ______________ Class______________

LESSON 2-4

Operations with Scientific Notation

Reading Strategies: Follow a Flowchart

A flowchart gives you a plan. You can use a flowchart to compute with numbers given in scientific notation.

To multiply numbers in scientific notation:

1		2		3		4
Multiply the decimal numbers.	⇨	Add the exponents of 10.	⇨	Write the product from Step 1 and the power from Step 2 in the format of scientific notation.	⇨	Check that the decimal is between 1 and 10. If not, adjust the decimal and the exponent so the answer is in scientific notation.

To divide numbers in scientific notation:

1		2		3		4
Divide the decimal numbers.	⇨	Subtract the exponents of 10.	⇨	Write the quotient from Step 1 and the power from Step 2 in the format of scientific notation.	⇨	Check that the decimal is between 1 and 10. If not, adjust the decimal and the exponent so the answer is in scientific notation.

To add or subtract numbers in scientific notation:

1		2		3		4
Check that the exponents on powers of 10 are the same. If not, adjust the decimal and the exponent.	⇨	As long as the exponents match, add or subtract the decimal numbers.	⇨	Write the sum or difference from Step 2 and the power from Step 1 in the format of scientific notation.	⇨	Check that the decimal is between 1 and 10. If not, adjust the decimal and the exponent so the answer is in scientific notation.

Identify which flowchart to follow. Perform the indicated operation.

1. $4.2 \times 10^3 + 2.4 \times 10^4$

   ____

2. $(1.2 \times 10^4)(1.6 \times 10^6)$

   ____

3. $\dfrac{8.8 \times 10^7}{4.4 \times 10^4}$

   ____

4. $(6.4 \times 10^3) \div (3.2 \times 10^4)$

   ____

5. $(3.2 \times 10^8) - (1.3 \times 10^7)$

   ____

6. $(7.0 \times 10^6)(4.7 \times 10^3)$

   ____

Name ______________________ Date ______________ Class______________

LESSON 2-4

Operations with Scientific Notation

Success for English Learners

When completing mathematical operations with integers, there are procedures that simplify the process.

Problem 1

You can add or subtract numbers in scientific notation.

$(5.9 \times 10^5) - (5.4 \times 10^4)$ ← Check to see if each power of 10 has the same exponent.

$(5.9 \times 10^5) - (0.54 \times 10^5)$ ← Adjust to get the same exponent.

$(5.9 - 0.54) \times 10^5$ ← Add or subtract the decimal parts. Use 10 to the common power.

5.36×10^5 ← Check that the answer is in scientific notation.✓

Problem 2

You can multiply or divide numbers in scientific notation.

$(3.5 \times 10^8) \times (9.1 \times 10^4)$

$(3.5 \times 9.1) \times (10^8 \times 10^4)$ ← Regroup so decimals and powers of 10 are grouped.

$(3.5 \times 9.1) \times 10^{8+4}$ ← Multiply or divide the decimal parts. If multiplying, add exponents. If dividing, subtract exponents.

31.85×10^{12} ← Check that the answer is in scientific notation.

3.185×10^{13} ← Answer in scientific notation.

Complete.

1. When is scientific notation most useful?

____

____

Compute. Write each answer in scientific notation.

2. $(1.43 \times 10^5) \div (2.6 \times 10^2)$

3. $(2.8 \times 10^6) - (1.3 \times 10^6)$

4. $(5.8 \times 10^6)(2.5 \times 10^3)$

5. $(2.9 \times 10^5) + (8.4 \times 10^4)$

6. $(1.8 \times 10^3)(3.4 \times 10^8)$

7. $(3.024 \times 10^9) \div (5.4 \times 10^4)$

Name ______________________ Date ______________ Class______________

MODULE 2

Exponents and Scientific Notation

Challenge

Astronomical Distances

1. A light year is the distance light travels in a vacuum in one year. It is about 9.4605284×10^{15} meters. Write this in standard form.

____

2. Change a light year to kilometers. Write it in both standard form and scientific notation. About how many trillions is this number?

____

3. Distances to stars are often measured in parsecs rather than in light years. One parsec is about 3.26 light years. Use scientific notation to write the number of kilometers in one parsec to three significant digits.

____

Subatomic Distances

4. Dimensions of subatomic particles are often described in nanometers. A nanometer is one-billionth of a meter. Write a nanometer in both standard form and scientific notation.

____

5. Sometimes atomic scale dimensions are written in angstroms. An angstrom equals 0.1 nanometer. Use scientific notation to show the value of an angstrom in meters.

____

6. A nanometer equals $\frac{1}{1000}$ of a micron. Use scientific notation to show the value of a micron in meters.

____

7. How many times larger than a nanometer is a parsec?

____

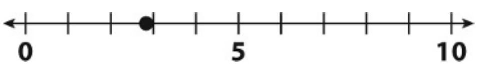
UNIT 1: Real Numbers, Exponents, and Scientific Notation

MODULE 1 Real Numbers

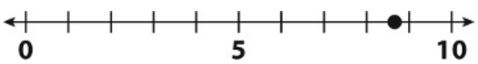
LESSON 1-1

Practice and Problem Solving: A/B

1. 0.125
2. 0.5625
3. 0.55
4. 5.32
5. $0.9\overline{3}$
6. $2.58\overline{3}$
7. 0.03
8. 3.2
9. 5, –5
10. 1, –1
11. $\frac{5}{2}, -\frac{5}{2}$
12. $\frac{11}{7}, -\frac{11}{7}$
13. 2
14. 6
15. 1
16. 13
17. 5.66
18. 10.86
19. 4.24
20. 17.86
21. 2.83



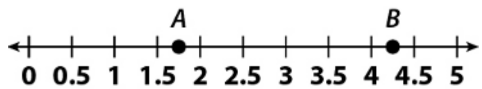
22. 8.66



23. $1\frac{23}{100}$ lb
24. 288 in^2

Practice and Problem Solving: C

1. 1.17 in.
2. 7.64 in.
3. Since $\frac{41}{50} = 0.82, \frac{9}{11} = 0.\overline{81}$, and $\frac{10}{11} = 0.\overline{90}$, $\frac{41}{50}$ is closer to $\frac{9}{11}$.
4. $\pm\frac{1}{2}$
5. $\pm\frac{1}{4}$
6. $\approx \pm\frac{2}{3}$
7. ≈ 1.73
8. ≈ 4.24



9. When you find a square root, you find two factors that are the same. They can be positive or negative. When you find a cube root, you find three factors that are the same. They are positive.
10. The length of one photo album page is 25 cm. The width of the page is 32 cm.

Practice and Problem Solving: D

1. $0.\overline{1}$
2. 0.55
3. 0.5625
4. $\frac{129}{500}$
5. $4\frac{4}{5}$
6. $\frac{333}{1000}$
7. 4, –4
8. 7, –7

9. $\frac{5}{2}, -\frac{5}{2}$

10. 7

11. 1

12. $\frac{2}{3}$

13. 5.66

14. 7.68

15. 10.86

16. 0.17 mi^2

17. 5 ft

Reteach

1. 3.75
2. $0.8\overline{3}$
3. $3.\overline{6}$
4. 9, –9
5. 7, –7
6. $\frac{5}{6}, -\frac{5}{6}$
7. 3
8. 5
9. 9

Reading Strategies

1. Yes, because it can be written as a fraction: $0.62 = \frac{62}{100} = \frac{31}{50}$.
2. No, because it cannot be written as a decimal that terminates or repeats.
3. Yes, as long as the decimal is infinite and nonrepeating, such as 0.31311311131111….
4. Yes, for example, $\frac{2}{3} = 0.\overline{6}$.
5. A decimal that is an irrational number is infinite and nonrepeating, such as the value for π.
6. Both are real numbers and both can be written as decimals.

Success for English Learners

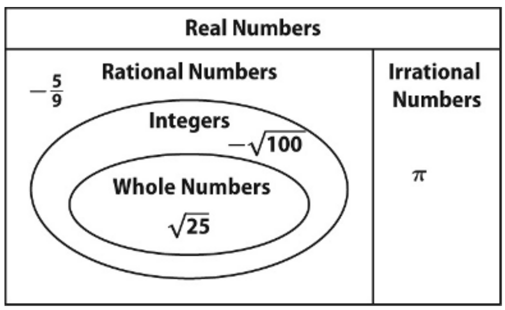
1. $\frac{1}{4} = 0.25$
2. Possible answer: If you have a square with a side length of 5, then 5^2 is how you find the area of that square.
3. Because the answer is an approximation.

LESSON 1-2

Practice and Problem Solving: A/B

1. real, rational
2. real, irrational
3. real, rational, integer
4. real, rational, integer
5. real, rational
6. real, rational, integer, whole
7. false; irrational real numbers include nonterminating decimals
8. true Possible explanation: Integers include all whole numbers and their opposites.
9. rational; all money amounts can be written as fractions
10. real numbers; the temperature can be any number between 0 and 100 degrees Celsius

11–14.



Practice and Problem Solving: C

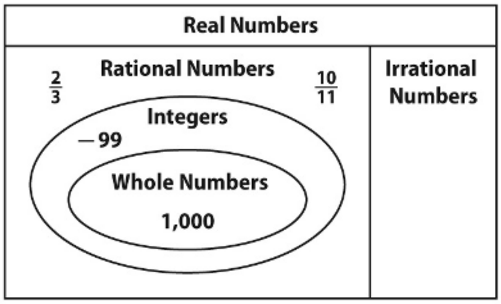
1. real, rational, integer
2. real, rational, integer
3. real, rational
4. real, rational, integer, whole
5. real, rational
6. real, rational, integer, whole

7. integers; possible points are positive and negative numbers
8. real; elevation can be any number above or below zero
9. no; there are an infinite number of rational numbers between any two integers
10. 10 will be whole numbers (square roots of 1, 4, 9, 16, 25, 36, 49, 64, 81, and 100); 90 will be irrational numbers
11. all of the negative numbers that are not fractions or decimals
12. all fractions, irrational numbers, or decimals less than 0

Practice and Problem Solving: D

1. real, rational
2. real, irrational
3. real, rational
4. real, rational, integer
5. real, rational
6. real, rational, integer, whole
7. true; all fractions are rational numbers, and all rational numbers are real numbers
8. false; Negative fractions and decimals are not integers.
9. whole numbers; There are 0 or more people in a movie theater.
10. real numbers; The square root of 1, 4, or 9 would be whole numbers, but the square root of 2, 3, 5, 6, 7, 8, 10, 11, or 12 would be irrational numbers. (Each cube can show 1 through 6, so the sum can be 2 through 12. Of these numbers, 4 and 9 are perfect squares, so their square roots are whole numbers. The other possible sums have square roots that are irrational. The set of numbers that contains whole numbers and irrational numbers is the real numbers.)

11–14.



Reteach

1. Yes
2. Yes; $\sqrt{16} = 4$, which can be written as $\frac{4}{1}$.
3. Yes
4. Is it a whole number? Yes.
5. real, rational, integer, whole

Reading Strategies

1. rational; irrational
2. fraction; decimal
3. terminating; repeating
4. positive; negative
5. counting
6. a. integers
   b. rational numbers
   c. whole numbers
   d. irrational numbers

Success for English Learners

1. real
2. not real
3. real, rational
4. real, rational, integer

LESSON 1-3

Practice and Problem Solving: A/B

1. $<$
2. $<$
3. $<$
4. $>$
5. $>$
6. $>$

7. Great white, White–angled sulphur, Large orange sulphur, Apricot sulphur
8. Between Large orange sulphur and Apricot sulphur
9. $\frac{\sqrt{7}}{2}$, 2, $\sqrt{8}$
10. π, $\sqrt{12}$, 3.5
11. –20, $\sqrt{26}$, $\sqrt{35}$, 13.5
12. –5.25, $\frac{3}{2}$, $\sqrt{6}$, 5
13. $1+\frac{\pi}{2}$, $\frac{5}{2}$, $\sqrt{12}-1$, 2.25

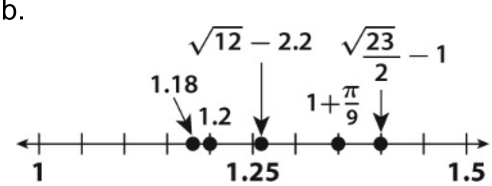
Practice and Problem Solving: C

1. a. $2\pi - 1.68$; $\sqrt{13}+1$; $4.\overline{6}$

   b. Yes, if you used $\pi \approx \frac{22}{7}$, then $2\pi - 1.68 \approx 4.6057142$, which would be greater than $\sqrt{13}+1 \approx 4.6055512$, so from least to greatest the order would be $\sqrt{13}+1$, $2\pi - 1.68$, and $4.\overline{6}$.

2. a. $\frac{\sqrt{23}}{2} - 1 \approx 1.40$; $1+\frac{\pi}{9} \approx 1.35$; $\sqrt{12} - 2.2 \approx 1.26$; 1.18

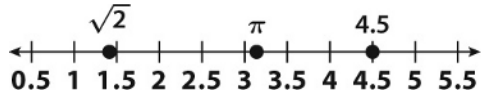
   b.



   c. Justin's shelf is suitable to use in the closet. The other shelves are too long. Justin's shelf is shorter than the closet width, but it can be held up using the 3.5–centimeter brackets.

Practice and Problem Solving: D

1. <
2. >
3. <
4. >
5. >
6. =
7.



   $\sqrt{2}$; π; 4.5

8. –10, $\frac{\sqrt{2}}{2}$, 2
9. $\sqrt{3}$, π, 7
10. –4, 1.5, $\sqrt{8}$
11. –5.5, $\frac{3}{2}$, $\sqrt{6}$
12. $\frac{5}{2}$, 2.6, $1+\sqrt{3}$, $\sqrt{8}$

Reteach

1. $\sqrt{8}$, π, 4
2. 5, $\pi + 2$, $\frac{17}{3}$
3. –2, $\sqrt{2}$, 1.7
4. $\frac{3}{2}$, $\sqrt{5}$, 2.5
5. $\sqrt{13}$, 3.7, $\pi+1$
6. $\frac{\sqrt{5}}{2}$, $\pi-2$, $\frac{5}{4}$

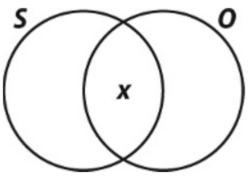
Reading Strategies

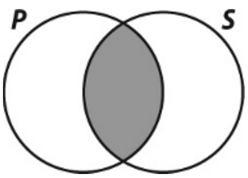
1. The square root of thirteen is less than four.
2. Five-hundred-and-one thousandths is approximately one half.
3. The square root of 25 equals 5.
4. Pi plus one is greater than two thirds. OR The sum of pi and one is greater than two thirds.
5. $\frac{18}{2} = 9$
6. $5.17 > \sqrt{23}$
7. $\frac{2}{3} < \pi$

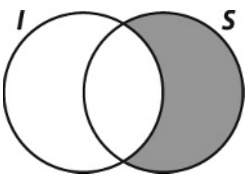
Success for English Learners

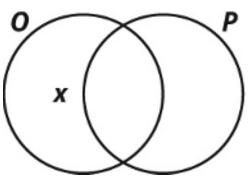
1. <
2. $\pi + 1$, $\sqrt{19}$, 4.4
3. Answers may vary. Sample answer: when comparing runners' marathon times

MODULE 1 Challenge

1. No square numbers are prime.
   No *S* is *P.*
2. Some prime numbers are odd.
   Some *P* is *O.*
3. All even numbers are integers.
   All *E* is *I.*
4. 

5. 

6. 

7. 

MODULE 2 Exponents and Scientific Notation

LESSON 2-1

Practice and Problem Solving: A/B

1. 125
2. $\frac{1}{49}$
3. 51
4. $\frac{1}{81}$
5. 1
6. 1
7. $\frac{1}{64}$
8. 64
9. 100,000
10. 6
11. 6
12. 3
13. 35
14. 5
15. $\frac{1}{16}$
16. 4096
17. 2^3 in^3; 10^3 in^3
18. 125
19. Sample answer: The box will hold the same number of balls as small boxes. With the balls, there is empty space.
20. 125; Sample answer: Find the volume of the box and of the cube. Divide the box volume by the cube volume.

Practice and Problem Solving: C

1. 1024
2. $\frac{1}{4}$
3. $\frac{2}{5}$
4. 10,000
5. $\frac{1}{144}$
6. 2048
7. 1; Explanations will vary. Sample answer: If you add all the exponents, you get $n - 21$ and when $n = 3$, $7n - 21 = 0$; $2^0 = 1$.
8. Predictions will vary.

9.

Number of Folds	0	1	2	3	4	5	6	7	8	9	10
Number of Rectangles	2^0, 1	2^1, 2	2^2, 4	2^3, 8	2^4, 16	2^5, 32	2^6, 64	2^7, 128	2^8, 256	2^9, 512	2^{10}, 1,024

10. Answers will vary.
11. Predictions will vary.
12. Answers will vary. Sample answer: Raise 2 to the power of the cut to see how many pieces. On the 5th cut, $2^5 = 32$ pieces.

Practice and Problem Solving: D

1. $\dfrac{1}{4\times4\times4\times4} = \dfrac{1}{256}$
2. $6 \times 6 = 36$
3. $3 \times 3 \times 3 \times 3 \times 3 = 243$
4. 1
5. $\dfrac{1}{7\times7} = \dfrac{1}{49}$
6. $10 \times 10 \times 10 \times 10 \times 10 = 100{,}000$
7. $\dfrac{(3 \bullet 2)^6}{(7-1)^4} = \dfrac{6^6}{6^4} = 6^{6-4} = 6^2 = 36$
8. $(3)^2 \bullet (3^1) = 3^{2+1} = 3^3 = 27$
9. $4^2 \bullet 4^3 = 4^{2+3} = 4^5 = 1024$
10. $(4^2)^3 = 4^{2\bullet3} = 4^6 = 4096$
11. $(4 - 3)^2 \bullet (5 \bullet 4)^0 = 1^2 \bullet 20^0 = 1 \bullet 1 = 1$
12. $(2 + 3)^5 \div (5^2)^2 = 5^5 \div 5^4 = 5^{5-4} = 5^1 = 5$
13. $(2^2)^3 = 2^6 = 64; (2^3)^2 = 2^6 = 64$; Both are equal. Explanations will vary.

Reteach

1. subtract; 27
2. add; $\dfrac{1}{8}$
3. multiply; 729
4. add; 625
5. subtract; $\dfrac{1}{16}$
6. multiply; 1296

Reading Strategies

1. The exponent decreases by 1 as you move down the column.
2. 3
3. 3
4. 4
5. 4
6.

Column 1	Column 2	Column 3
$5^3 = 125$	$6^3 = 216$	$10^3 = 1000$
$5^2 = 25$	$6^2 = 36$	$10^2 = 100$
$\mathbf{5^1 = 5}$	$\mathbf{6^1 = 6}$	$\mathbf{10^1 = 10}$
$\mathbf{5^0 = 1}$	$\mathbf{6^0 = 1}$	$\mathbf{10^0 = 1}$
$\mathbf{5^{-1} = \dfrac{1}{5}}$	$\mathbf{6^{-1} = \dfrac{1}{6}}$	$\mathbf{10^{-1} = \dfrac{1}{10}}$
$\mathbf{5^{-5} = \dfrac{1}{25}}$	$\mathbf{6^{-2} = \dfrac{1}{36}}$	$\mathbf{10^{-2} = \dfrac{1}{100}}$

Success for English Learners

1. Answers will vary. Sample answer: A negative exponent tells you how many times you use the base as a divisor.
2. 9
3. 64
4. x^{20}
5. 4096
6. 12
7. z^{12}

LESSON 2-2

Practice and Problem Solving: A/B

1. 10^2
2. 10^4
3. 10^5

4. 10^7
5. 10^6
6. 10^3
7. 10^9
8. 10^0
9. 1000
10. 100,000
11. 10
12. 1,000,000
13. 100
14. 1
15. 10,000
16. 10,000,000
17. 2.5×10^3
18. 3×10^2
19. 4.73×10^4
20. 2.4×10^1
21. 1.4565×10^4
22. 7.001×10^3
23. 1.905×10^7
24. 3.3×10^1
25. 6000
26. 450
27. 70,000,000
28. 10,500
29. 3052
30. 5
31. 98.7
32. 54.3
33. 3.844×10^5 km
34. 6380 km

Practice and Problem Solving: C

1. $2500 < 2,500,000$
2. $5,000,000 > 2,500,000$
3. $3 < 10$
4. $4025 < 10,250$
5. 4.50×10^2; 1.2×10^3
6. 2.3×10^5; 3.2×10^4
7. 2.35×10^5; 3.25×10^5; 5.32×10^5; 2.35×10^6; 3.25×10^6; 5.32×10^6
8. 0×10^0; 1×10^0; 5×10^0; 1×10^1; 5×10^1
9. False; 1×10^3 m $= 1 \times 10^3 \times 10^1$ cm $=$ 1×10^4 cm, which is less than 1×10^6 cm
10. False; 9×10^1 m $\times\ 9 \times 10^1 \times 10^3$ mm $=$ 9×10^4 mm, which is not equal to 9×10^1 mm
11. $15,000 - 9,000 = 6,000$; 6,000 tickets are available
12. $1.5 \times 10^4 = 15,000$, and $15,000 > 2500$, so the athletic team is more popular

Practice and Problem Solving: D

1. 100
2. 100,000
3. 10,000
4. 1000
5. $10 \times 10 \times 10 \times 10 \times 10$
6. $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$
7. $10 \times 10 \times 10 \times 10$
8. $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$
9. 10^3
10. 10^1
11. 10^5
12. 10
13. 1000
14. 10,000
15. 1,000,000,000
16. 100,000
17. 1
18. 3
19. 2
20. 6
21. 0
22. 3560
23. 9000
24. 68,750
25. 4,005,000
26. 1000 ft^3

Reteach

1. 3.46; 4; 3.46×10^4
2. 1.0502; 6; 1.0502×10^6

3. 1057
4. 300,000,000
5. 524,000

Reading Strategies

1. 2; 2.95; 2; 2.95×10^2
2. 1; 1.05; 4; 1.05×10^4
3. 4; 4.505; 6; 4.505×10^6
4. between 2 and 9; 4; 25,000
5. after the 7; 5; 700,000
6. between 1 and 2; 3; 1234

Success for English Learners

1. $3.28 \times 10^5 > 3.28 \times 10^3$ because $3.28 \times 10^5 = 328,000$ and $3.28 \times 10^3 = 3280$.
2. A car; 3×10^6=3,000,000 g, or 3,000 kg, and a car would weigh many kilograms but a hair would not.
3. 1.86×10^5
4. 4,567.89

LESSON 2-3

Practice and Problem Solving: A/B

1. 10^{-2}
2. 10^{-4}
3. 10^{-5}
4. 10^{-7}
5. 10^{-6}
6. 10^{-3}
7. 10^{-9}
8. 10^{-1}
9. 0.001
10. 0.00001
11. 0.1
12. 0.000001
13. 0.01
14. 0.000000001
15. 0.0001
16. 0.0000001
17. 2.5×10^{-2}
18. 3×10^{-1}
19. 4.73×10^{-4}
20. 2.4×10^{-3}
21. 1.4565×10^{-5}
22. 7.001×10^{-1}
23. 1.905×10^{-2}
24. 3.3×10^{-3}
25. 0.006
26. 0.045
27. 0.0000007
28. 0.00000105
29. 0.00000003052
30. 0.5
31. 0.000987
32. 0.0000543
33. 0.0000005 m
34. 1.7×10^{-5} m

Practice and Problem Solving: C

1. 0.0052; 0.0000052; >
2. 0.000005; 0.000025; <
3. 3; 0.1; >
4. 0.00502; 0.000205; >
5. 1.2×10^{-3}; 4.5×10^{-1}
6. 3.2×10^{-4}; 2.3×10^{-6}
7. 2.35×10^{-6}, 3.25×10^{-6}, 5.32×10^{-6}, 2.35×10^{-5}, 3.25×10^{-5}, 5.32×10^{-5}
8. 0×10^0, 1×10^{-1}, 5×10^{-1},1×10^0, 5×10^0
9. 1×10^{-3} m = 1 mm; 1×10^{-1} cm = 1 mm; equal, so false
10. 7×10^{-1} cm = 7 mm; 7×10^{-3} m = 7 mm; equal, so false
11. 3.5×10^{-1} cm = 3.5 mm; 3.5×10^{-3} m = 3.5 mm; equal, so true
12. 9×10^{-1} mm; 9×10^{-4} m = 9×10^{-1} mm; equal, so true
13. 9×10^{-3} liters = 0.009 liters; 3×10^{-5} liters = 0.00003; $0.009 \div 0.00003 = 300$ drops
14. 0.00025 meters = 2.5×10^{-4}; 0.000125 meters = 1.25×10^{-4}; area = length × width = $(2.5 \times 10^{-4}) \times (1.25 \times 10^{-4}) = 3.125 \times 10^{-8}$ square meters

Practice and Problem Solving: D

1. $\frac{1}{100}$
2. $\frac{1}{100{,}000}$
3. $\frac{1}{10{,}000}$
4. $\frac{1}{1000}$
5. $\frac{1}{10 \times 10 \times 10 \times 10 \times 10}$
6. $\frac{1}{10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10}$
7. $\frac{1}{10 \times 10 \times 10 \times 10}$
8. $\frac{1}{10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10}$
9. $\frac{1}{10^3} = 10^{-3}$
10. $\frac{1}{10^1} = 10^{-1}$
11. $\frac{1}{10^2} = 10^{-2}$
12. $\frac{1}{10^4} = 10^{-4}$
13. $\frac{1}{10}$
14. $\frac{1}{1000}$
15. $\frac{1}{10{,}000}$
16. $\frac{1}{1{,}000{,}000{,}000}$
17. $\frac{1}{100{,}000}$
18. $\frac{1}{1{,}000{,}000{,}000{,}000}$
19. –4
20. –1
21. –8
22. –3
23. 0.00356
24. 0.00009
25. 0.0006875
26. 0.000004005
27. 0.15 ft^2; 1.5×10^{-1}

Reteach

1. 2.79×10^{-2}
2. 7.1×10^{-5}
3. 5.06×10^{-7}
4. 0.000235
5. 0.0065
6. 0.0000707

Reading Strategies

1. 1; 3; right; –3; 1.23×10^{-3}
2. 5; 6; right; –6; 5.67×10^{-6}
3. –8; left; 8; 0.000000067
4. –4; left; 4; 0.000321

Success for English Learners

1. $5.75 \times 10^{-3} > 5.75 \times 10^{-4}$ because $5.75 \times 10^{-3} = 0.00575$ and $5.75 \times 10^{-4} =$ 0.000575.
2. A hair; $3 \times 10^{-7} = 0.0000003$ g, and a hair would have a mass that is less than a gram, but a bicycle would not.
3. 4.93×10^{-4}
4. 0.0000321

LESSON 2-4

Practice and Problem Solving: A/B

1. 2.79×10^4
2. 3.83×10^6
3. 6.67×10^9
4. 4.48×10^4
5. 4.16×10^{17}
6. 2.0×10^3
7. 8.85×10^{10}
8. 6.0×10^7
9. 4.1E + 4
10. 9.4E – 6
11. 5.2×10^{-6}
12. 8.3×10^2

13. 7.0×10^4
14. 1.4×10^4
15. 1.6×10^4
16. about 3.0×10^4, or about 30,000 strides

Practice and Problem Solving: C

1. 3.574×10^4
2. 5.416×10^4
3. 1.6897×10^7
4. 7.08×10^3
5. 2.496×10^{13}
6. 7.0×10^{12}
7. 2.89×10^{-2}
8. 2.3×10^{-4}
9. 6.0×10^{-2}
10. 3.65×10^2
11. 3.15×10^8
12. 6.8985×10^9 kilowatt hours; 6,898,500,000 kilowatt hours
13. 459,900 households

Practice and Problem Solving: D

1. 4.044×10^4
2. 1.028×10^4
3. 2.8×10^6
4. 5.65×10^4
5. 2.048×10^{13}
6. 1.92×10^1
7. 1.025×10^9
8. 2.0×10^8
9. 3.3×10^{-3}, 6.9×10^5
10. 7.1E + 5, 4.4E − 3
11. 1.0×10^6
12. $\dfrac{1.0 \times 10^6}{8.64 \times 10^4} \approx$ 0.116×10^2 or $1.16 \times 10^1 \approx 11.6$ days

Reteach

1. 6.5×10^2
2. 1.5×10^6
3. 2.1×10^8

Reading Strategies

1. 2.82×10^4
2. 1.92×10^{10}
3. 2.0×10^3
4. 2.0×10^{-1}
5. 3.07×10^8
6. 3.29×10^{10}

Success for English Learners

1. Sample answer: When dealing with very large or very small numbers
2. 5.5×10^2
3. 1.5×10^6
4. 1.45×10^{10}
5. 3.74×10^5
6. 6.12×10^{11}
7. 5.6×10^4

MODULE 2 Challenge

1. 9,460,528,400,000,000 m; rounded, this is 9 trillion km
2. 9,460,528,400,000 km; 9.4605284×10^{12} km; almost 10 trillion
3. $(9.4605284 \times 10^{12}$ km$)(3.26)$; 3.08×10^{13} km
4. 0.000000001 m; 1×10^{-9} m
5. $(1 \times 10^{-9}\text{ m})(0.1) = 1 \times 10^{-10}$ m
6. $(1 \times 10^{-9}\text{ m})(1{,}000) = 1 \times 10^{-6}$ m
7. $\dfrac{3.08 \times 10^{16}}{1.0 \times 10^{-9}} = 3.08 \times 10^{25}$; 1 parsec is about 3×10^{25} nanometers