Name_____ Date _____

Chapter 10 Fair Game Review

Evaluate the expression.

1. $2 + 1 \bullet 4^2 - 12 \div 3$

2. $8^2 \div 16 \bullet 2 - 5$

3. $7(9 - 3) + 6^2 \bullet 10 - 8$

4. $3 \bullet 5 - 10 + 9(2 + 1)^2$

5. $8(6 + 5) - (9^2 + 3) \div 7$

6. $5[3(12 - 8)] - 6 \bullet 8 + 2^2$

7. $4 + 4 + 5 \times 2 \times 5 + (3 + 3 + 3) \times 6 \times 6 + 2 + 2$

a. Evaluate the expression.

b. Rewrite the expression using what you know about order of operations. Then evaluate.

Name _____ Date _____

Chapter 10 Fair Game Review (continued)

Find the product or quotient.

8. $3.92 \bullet 0.6$

9. $0.78 \bullet 0.13$

10. $\begin{array}{r} 5.004 \\ \times\ \ 1.2 \\ \hline \end{array}$

11. $6.3 \div 0.7$

12. $2.25 \div 1.5$

13. $0.003\overline{)8.1}$

14. Grapes cost $1.98 per pound. You buy 3.5 pounds of grapes. How much do you pay for the grapes?

Name_____ Date _____

10.1 Exponents

For use with Activity 10.1

Essential Question How can you use exponents to write numbers?

The expression 3^5 is called a *power*. The *base* is 3. The *exponent* is 5.

base → 3^5 ← exponent

1 ACTIVITY: Using Exponent Notation

Work with a partner.

a. Complete the table.

Power	Repeated Multiplication Form	Value
$(-3)^1$		
$(-3)^2$		
$(-3)^3$		
$(-3)^4$		
$(-3)^5$		
$(-3)^6$		
$(-3)^7$		

b. **REPEATED REASONING** Describe what is meant by the expression $(-3)^n$.

How can you find the value of $(-3)^n$?

2 ACTIVITY: Using Exponent Notation

Work with a partner.

a. The cube at the right has $3 in each of its small cubes. Write a power that represents the total amount of money in the large cube.

b. Evaluate the power to find the total amount of money in the large cube.

3 ACTIVITY: Writing Powers as Whole Numbers

Work with a partner. Write each distance as a whole number. Which numbers do you know how to write in words? For instance, in words, 10^3 is equal to *one thousand*.

a. 10^{26} meters:
diameter of observable universe

b. 10^{21} meters:
diameter of Milky Way galaxy

c. 10^{16} meters:
diameter of solar system

d. 10^{7} meters:
diameter of Earth

e. 10^{6} meters:
length of Lake Erie shoreline

f. 10^{5} meters:
width of Lake Erie

Name_____ Date _____

10.1 Exponents (continued)

4 ACTIVITY: Writing a Power

Work with a partner. Write the number of kits, cats, sacks, and wives as a power.

As I was going to St. Ives
I met a man with seven wives
Each wife had seven sacks
Each sack had seven cats
Each cat had seven kits
Kits, cats, sacks, wives
How many were going to St. Ives?

Nursery Rhyme, 1730

What Is Your Answer?

5. IN YOUR OWN WORDS How can you use exponents to write numbers? Give some examples of how exponents are used in real life.

Name _____ Date _____

10.1 Practice

For use after Lesson 10.1

Write the product using exponents.

1. $4 \bullet 4 \bullet 4 \bullet 4 \bullet 4$

2. $\left(-\frac{1}{8}\right) \bullet \left(-\frac{1}{8}\right) \bullet \left(-\frac{1}{8}\right)$

3. $5 \bullet 5 \bullet (-x) \bullet (-x) \bullet (-x) \bullet (-x)$

4. $9 \bullet 9 \bullet y \bullet y \bullet y \bullet y \bullet y \bullet y$

Evaluate the expression.

5. 10^3

6. $(-7)^4$

7. $-\left(\frac{1}{6}\right)^5$

8. $3 + 6 \bullet (-5)^2$

9. $\left| -\frac{1}{3}\left(1^{10} + 9 - 2^3\right) \right|$

10. A foam toy is 2 inches wide. It doubles in size for every minute it is in water. Write an expression for the width of the toy after 5 minutes. What is the width after 5 minutes?

Name_____ Date _____

10.2 Product of Powers Property

For use with Activity 10.2

Essential Question How can you use inductive reasoning to observe patterns and write general rules involving properties of exponents?

1 ACTIVITY: Finding Products of Powers

Work with a partner.

a. Complete the table.

Product	Repeated Multiplication Form	Power
$2^2 \bullet 2^4$		
$(-3)^2 \bullet (-3)^4$		
$7^3 \bullet 7^2$		
$5.1^1 \bullet 5.1^6$		
$(-4)^2 \bullet (-4)^2$		
$10^3 \bullet 10^5$		
$\left(\frac{1}{2}\right)^5 \bullet \left(\frac{1}{2}\right)^5$		

b. **INDUCTIVE REASONING** Describe the pattern in the table. Then write a *general rule* for multiplying two powers that have the same base.

$a^m \bullet a^n = a$ ——

c. Use your rule to simplify the products in the first column of the table above. Does your rule give the results in the third column?

d. Most calculators have *exponent* keys that are used to evaluate powers. Use a calculator with an exponent key to evaluate the products in part (a).

2 ACTIVITY: Writing a Rule for Powers of Powers

Work with a partner. Write the expression as a single power. Then write a *general rule* for finding a power of a power.

a. $\left(3^2\right)^3 =$

b. $\left(2^2\right)^4 =$

c. $\left(7^3\right)^2 =$

d. $\left(y^3\right)^3 =$

e. $\left(x^4\right)^2 =$

3 ACTIVITY: Writing a Rule for Powers of Products

Work with a partner. Write the expression as the product of two powers. Then write a *general rule* for finding a power of a product.

a. $(2 \bullet 3)^3 =$

b. $(2 \bullet 5)^2 =$

c. $(5 \bullet 4)^3 =$

d. $(6a)^4 =$

e. $(3x)^2 =$

10.2 Product of Powers Property (continued)

4 ACTIVITY: The Penny Puzzle

Work with a partner.

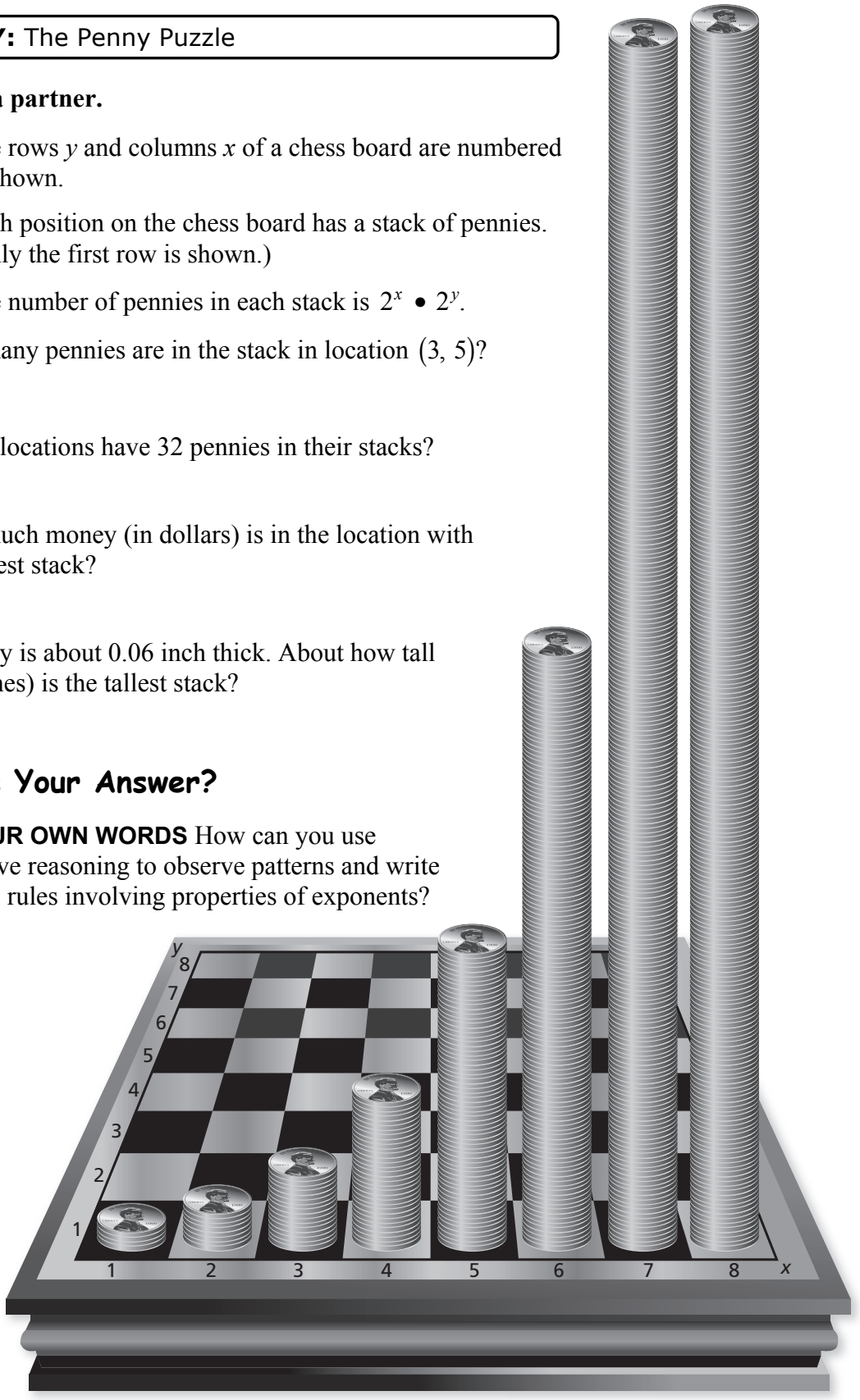
- The rows y and columns x of a chess board are numbered as shown.
- Each position on the chess board has a stack of pennies. (Only the first row is shown.)
- The number of pennies in each stack is $2^x \bullet 2^y$.

a. How many pennies are in the stack in location $(3, 5)$?

b. Which locations have 32 pennies in their stacks?

c. How much money (in dollars) is in the location with the tallest stack?

d. A penny is about 0.06 inch thick. About how tall (in inches) is the tallest stack?



What Is Your Answer?

5. IN YOUR OWN WORDS How can you use inductive reasoning to observe patterns and write general rules involving properties of exponents?

Name _____ Date _____

10.2 Practice

For use after Lesson 10.2

Simplify the expression. Write your answer as a power.

1. $(-6)^5 \bullet (-6)^4$

2. $x^1 \bullet x^9$

3. $\left(\frac{4}{5}\right)^3 \bullet \left(\frac{4}{5}\right)^{12}$

4. $(-1.5)^{11} \bullet (-1.5)^{11}$

5. $\left(y^{10}\right)^{20}$

6. $\left(\left(-\frac{2}{9}\right)^8\right)^7$

Simplify the expression.

7. $(2a)^6$

8. $(-4b)^4$

9. $\left(-\frac{9}{10}p\right)^2$

10. $(xy)^{15}$

11. $10^5 \bullet 10^3 - \left(10^1\right)^8$

12. $7^2\left(7^4 \bullet 7^4\right)$

13. The surface area of the Sun is about $4 \times 3.141 \times \left(7 \times 10^5\right)^2$ square kilometers. Simplify the expression.

Name_____ Date _____

10.3 Quotient of Powers Property

For use with Activity 10.3

Essential Question How can you divide two powers that have the same base?

1 ACTIVITY: Finding Quotients of Powers

Work with a partner.

a. Complete the table.

Quotient	Repeated Multiplication Form	Power
$\frac{2^4}{2^2}$		
$\frac{(-4)^5}{(-4)^2}$		
$\frac{7^7}{7^3}$		
$\frac{8.5^9}{8.5^6}$		
$\frac{10^8}{10^5}$		
$\frac{3^{12}}{3^4}$		
$\frac{(-5)^7}{(-5)^5}$		
$\frac{11^4}{11^1}$		

b. **INDUCTIVE REASONING** Describe the pattern in the table. Then write a rule for dividing two powers that have the same base.

$$\frac{a^m}{a^n} = a^{\_\_\_\_}$$

Name _____ Date _____

10.3 Quotient of Powers Property (continued)

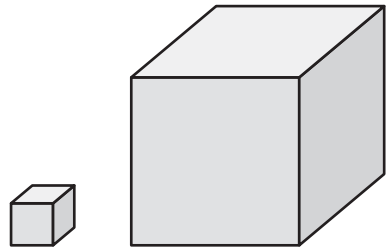
c. Use your rule to simplify the quotients in the first column of the table on the previous page. Does your rule give the results in the third column?

2 ACTIVITY: Comparing Volumes

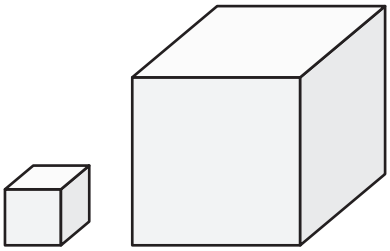
Work with a partner.

How many of the smaller cubes will fit inside the larger cube? Record your results in the table on the next page. Describe the pattern in the table.

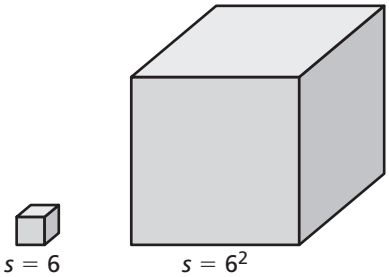
a.



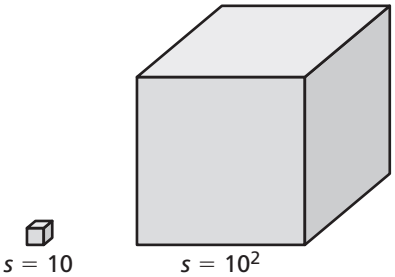
b.



c.



d.



10.3 Quotient of Powers Property (continued)

	Volume of Smaller Cube	Volume of Larger Cube	$\frac{\text{Larger Volume}}{\text{Smaller Volume}}$	Answer
a.				
b.				
c.				
d.				

What Is Your Answer?

3. **IN YOUR OWN WORDS** How can you divide two powers that have the same base? Give two examples of your rule.

Name _____ Date _____

10.3 Practice

For use after Lesson 10.3

Simplify the expression. Write your answer as a power.

1. $\frac{7^6}{7^5}$

2. $\frac{(-21)^{15}}{(-21)^9}$

3. $\frac{(3.9)^{20}}{(3.9)^{10}}$

4. $\frac{t^7}{t^3}$

5. $\frac{8^7 \bullet 8^4}{8^9}$

6. $\frac{(-1.1)^{13} \bullet (-1.1)^{12}}{(-1.1)^{10} \bullet (-1.1)^1}$

Simplify the expression.

7. $\frac{k \bullet 3^9}{3^5}$

8. $\frac{x^4 \bullet y^{10} \bullet 2^{11}}{y^8 \bullet 2^7}$

9. The radius of a basketball is about 3.6 times greater than the radius of a tennis ball. How many times greater is the volume of a basketball than the volume of a tennis ball? $\left(\text{Note: The volume of a sphere is } V = \frac{4}{3}\pi r^3.\right)$

Name_____ Date _____

10.4 Zero and Negative Exponents

For use with Activity 10.4

Essential Question How can you evaluate a nonzero number with an exponent of zero? How can you evaluate a nonzero number with a negative integer exponent?

1 ACTIVITY: Using the Quotient of Powers Property

Work with a partner.

a. Complete the table.

Quotient	Quotient of Powers Property	Power
$\frac{5^3}{5^3}$		
$\frac{6^2}{6^2}$		
$\frac{(-3)^4}{(-3)^4}$		
$\frac{(-4)^5}{(-4)^5}$		

b. **REPEATED REASONING** Evaluate each expression in the first column of the table. What do you notice?

c. How can you use these results to define a^0 where $a \neq 0$?

Name _____ Date _____

10.4 Zero and Negative Exponents (continued)

2 ACTIVITY: Using the Product of Powers Property

Work with a partner.

a. Complete the table.

Product	Product of Powers Property	Power
$3^0 \bullet 3^4$		
$8^2 \bullet 8^0$		
$(-2)^3 \bullet (-2)^0$		
$\left(-\frac{1}{3}\right)^0 \bullet \left(-\frac{1}{3}\right)^5$		

b. Do these results support your definition in Activity 1(c)?

3 ACTIVITY: Using the Product of Powers Property

Work with a partner.

a. Complete the table.

Product	Product of Powers Property	Power
$5^{-3} \bullet 5^3$		
$6^2 \bullet 6^{-2}$		
$(-3)^4 \bullet (-3)^{-4}$		
$(-4)^{-5} \bullet (-4)^5$		

b. According to your results from Activities 1 and 2, the products in the first column are equal to what value?

10.4 Zero and Negative Exponents (continued)

c. REASONING How does the Multiplicative Inverse Property help you to rewrite the numbers with negative exponents?

d. STRUCTURE Use these results to define a^{-n} where $a \neq 0$ and n is an integer.

4 ACTIVITY: Using a Place Value Chart

Work with a partner. Use the place value chart that shows the number 3452.867.

Place Value Chart

thousands	hundreds	tens	ones	and	tenths	hundredths	thousandths
10^3	10^2	10^1	$10^{\square}$		$10^{\square}$	$10^{\square}$	$10^{\square}$
3	4	5	2	.	8	6	7

a. REPEATED REASONING What pattern do you see in the exponents? Continue the pattern to find the other exponents.

b. STRUCTURE Show how to write the expanded form of 3452.867.

What Is Your Answer?

5. IN YOUR OWN WORDS How can you evaluate a nonzero number with an exponent of zero? How can you evaluate a nonzero number with a negative integer exponent?

Name _____ Date _____

10.4 Practice

For use after Lesson 10.4

Evaluate the expression.

1. 29^0

2. 12^{-1}

3. $10^{-4} \bullet 10^{-6}$

4. $\frac{1}{3^{-3}} \bullet \frac{1}{3^5}$

Simplify. Write the expression using only positive exponents.

5. $19x^{-6}$

6. $\frac{14a^{-5}}{a^{-8}}$

7. $3t^6 \bullet 8t^{-6}$

8. $\frac{12s^{-1} \bullet 4^{-2} \bullet r^3}{s^2 \bullet r^5}$

9. The density of a proton is about $\frac{1.64 \times 10^{-24}}{3.7 \times 10^{-38}}$ grams per cubic centimeter. Simplify the expression.

Name_____ Date _____

10.5 Reading Scientific Notation

For use with Activity 10.5

Essential Question How can you read numbers that are written in scientific notation?

1 ACTIVITY: Very Large Numbers

Work with a partner.

- Use a calculator. Experiment with multiplying large numbers until your calculator displays an answer that is *not* in standard form.
- When the calculator at the right was used to multiply 2 billion by 3 billion, it listed the result as

  6.0E+18.

- Multiply 2 billion by 3 billion by hand. Use the result to explain what 6.0E+18 means.

- Check your explanation using products of other large numbers.
- Why didn't the calculator show the answer in standard form?

- Experiment to find the maximum number of digits your calculator displays. For instance, if you multiply 1000 by 1000 and your calculator shows 1,000,000, then it can display 7 digits.

2 ACTIVITY: Very Small Numbers

Work with a partner.

- Use a calculator. Experiment with multiplying very small numbers until your calculator displays an answer that is *not* in standard form.
- When the calculator at the right was used to multiply 2 billionths by 3 billionths, it listed the result as

  $6.0\text{E}{-18}$.

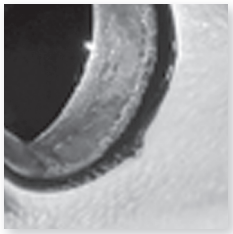
- Multiply 2 billionths by 3 billionths by hand. Use the result to explain what $6.0\text{E}{-18}$ means.
- Check your explanation by calculating the products of other very small numbers.

3 ACTIVITY: Powers of 10 Matching Game

Work with a partner. Match each picture with its power of 10. Explain your reasoning.

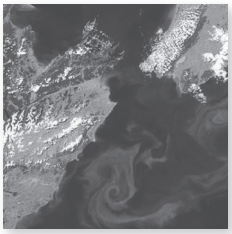
10^5 m	10^2 m	10^0 m	10^{-1} m	10^{-2} m	10^{-5} m

A.



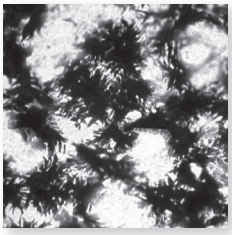
B.

C.



D.

E.



F.

Name_____ Date _____

10.5 Reading Scientific Notation (continued)

4 ACTIVITY: Choosing Appropriate Units

Work with a partner. Match each unit with its most appropriate measurement.

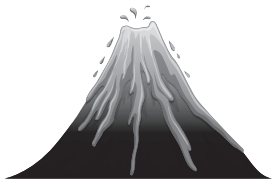
inches	centimeters	feet	millimeters	meters

a. Height of a door:

2×10^0

b. Height of a volcano

1.6×10^4



c. Length of a pen:

1.4×10^2

d. Diameter of a steel ball bearing:

6.3×10^{-1}

e. Circumference of a beach ball:

7.5×10^1

What Is Your Answer?

5. IN YOUR OWN WORDS How can you read numbers that are written in scientific notation? Why do you think this type of notation is called "scientific notation"? Why is scientific notation important?

Name _____ Date _____

10.5 Practice

For use after Lesson 10.5

Tell whether the number is written in scientific notation. Explain.

1. 14×10^{8}

2. 2.6×10^{12}

3. 4.79×10^{-8}

4. 3.99×10^{16}

5. 0.15×10^{22}

6. 6×10^{3}

Write the number in standard form.

7. 4×10^{9}

8. 2×10^{-5}

9. 3.7×10^{6}

10. 4.12×10^{-3}

11. 7.62×10^{10}

12. 9.908×10^{-12}

13. Light travels at 3×10^{8} meters per second.

a. Write the speed of light in standard form.

b. How far has light traveled after 5 seconds?

Name_____ Date _____

10.6 Writing Scientific Notation

For use with Activity 10.6

Essential Question How can you write a number in scientific notation?

1 ACTIVITY: Finding pH Levels

Work with a partner. In chemistry, pH is a measure of the activity of dissolved hydrogen ions (H^+). Liquids with low pH values are called *acids*. Liquids with high pH values are called *bases*.

Find the pH of each liquid. Is the liquid a base, neutral, or an acid?

a. Lime juice: $[H^+] = 0.01$

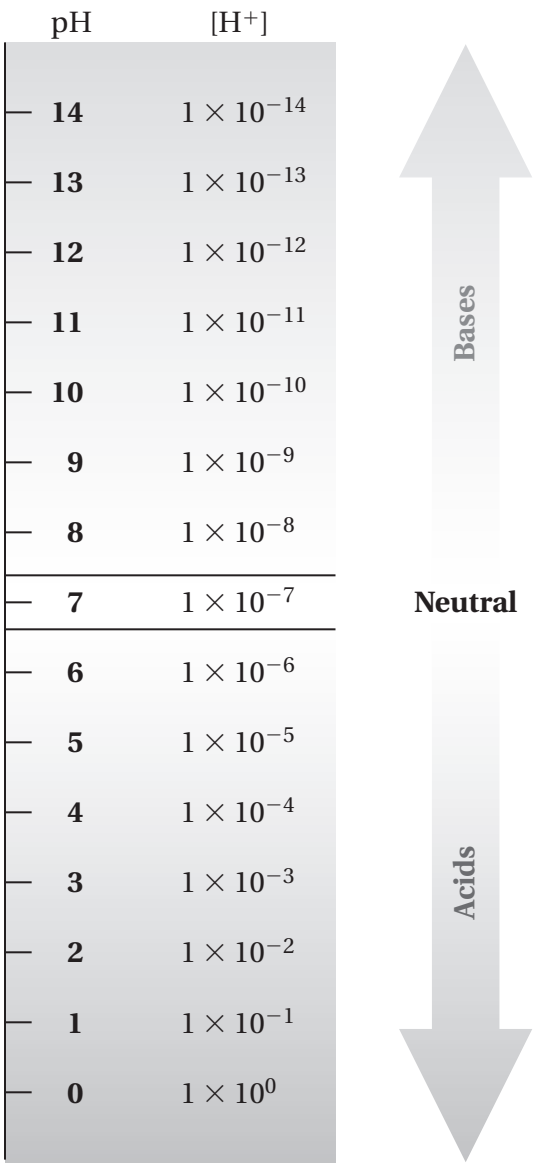
b. Egg: $[H^+] = 0.00000001$

c. Distilled water: $[H^+] = 0.0000001$

d. Ammonia water: $[H^+] = 0.00000000001$

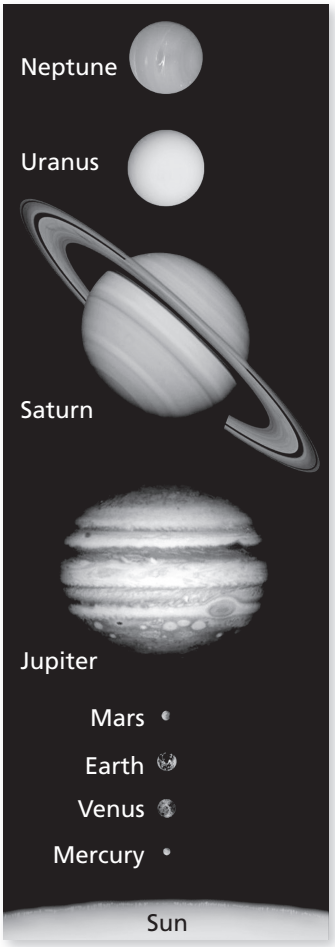
e. Tomato juice: $[H^+] = 0.0001$

f. Hydrochloric acid: $[H^+] = 1$



2 ACTIVITY: Writing Scientific Notation

Work with a partner. Match each planet with its distance from the Sun. Then write each distance in scientific notation. Do you think it is easier to match the distances when they are written in standard form or in scientific notation? Explain.



a. 1,800,000,000 miles

b. 67,000,000 miles

c. 890,000,000 miles

d. 93,000,000 miles

e. 140,000,000 miles

f. 2,800,000,000 miles

g. 480,000,000 miles

h. 36,000,000 miles

10.6 Writing Scientific Notation (continued)

3 ACTIVITY: Making a Scale Drawing

Work with a partner. The illustration in Activity 2 is not drawn to scale. Use the instructions below to make a scale drawing of the distances in our solar system.

- **Cut a sheet of paper into three strips of equal width. Tape the strips together.**
- **Draw a long number line. Label the number line in hundreds of millions of miles.**
- **Locate each planet's position on the number line.**

What Is Your Answer?

4. **IN YOUR OWN WORDS** How can you write a number in scientific notation?

Name _____ Date _____

10.6 Practice

For use after Lesson 10.6

Write the number in scientific notation.

1. 4,200,000

2. 0.038

3. 600,000

4. 0.0000808

5. 0.0007

6. 29,010,000,000

Order the numbers from least to greatest.

7. $6.4 \times 10^8, 5.3 \times 10^9, 2.3 \times 10^8$

8. $9.1 \times 10^{-3}, 9.6 \times 10^{-3}, 9.02 \times 10^{-3}$

9. $7.3 \times 10^7, 5.6 \times 10^{10}, 3.7 \times 10^9$

10. $1.4 \times 10^{-5}, 2.01 \times 10^{-15}, 6.3 \times 10^{-2}$

11. A patient has 0.0000075 gram of iron in 1 liter of blood. The normal level is between 6×10^{-7} gram and 1.6×10^{-5} gram. Is the patient's iron level normal? Write the patient's amount of iron in scientific notation.

Name_____ Date _____

10.7 Operations in Scientific Notation

For use with Activity 10.7

Essential Question How can you perform operations with numbers written in scientific notation?

1 ACTIVITY: Adding Numbers in Scientific Notation

Work with a partner. Consider the numbers 2.4×10^3 and 7.1×10^3.

a. Explain how to use order of operations to find the sum of these numbers. Then find the sum.

$$2.4 \times 10^3 + 7.1 \times 10^3$$

b. The factor ____ is common to both numbers. How can you use the Distributive Property to rewrite the sum $\left(2.4 \times 10^3\right) + \left(7.1 \times 10^3\right)$?

$\left(2.4 \times 10^3\right) + \left(7.1 \times 10^3\right) =$ _____ Distributive Property

c. Use order of operations to evaluate the expression you wrote in part (b). Compare the result with your answer in part (a).

d. **STRUCTURE** Write a rule you can use to add numbers written in scientific notation where the powers of 10 are the same. Then test your rule using the sums below.

- $\left(4.9 \times 10^5\right) + \left(1.8 \times 10^5\right) =$ _____
- $\left(3.85 \times 10^4\right) + \left(5.72 \times 10^4\right) =$ _____

2 ACTIVITY: Adding Numbers in Scientific Notation

Work with a partner. Consider the numbers 2.4×10^3 and 7.1×10^4.

a. Explain how to use order of operations to find the sum of these numbers. Then find the sum.

$$2.4 \times 10^3 + 7.1 \times 10^4$$

10.7 Operations in Scientific Notation (continued)

b. How is this pair of numbers different from the pair of numbers in Activity 1?

c. Explain why you cannot immediately use the rule you wrote in Activity 1(d) to find this sum.

d. **STRUCTURE** How can you rewrite one of the numbers so that you can use the rule you wrote in Activity 1(d)? Rewrite one of the numbers. Then find the sum using your rule and compare the result with your answer in part (a).

e. **REASONING** Does this procedure work when subtracting numbers written in scientific notation? Justify your answer by evaluating the differences below.

- $(8.2 \times 10^5) - (4.6 \times 10^5) =$ _____
- $(5.88 \times 10^5) - (1.5 \times 10^4) =$ _____

3 ACTIVITY: Multiplying Numbers in Scientific Notation

Work with a partner. Match each step with the correct description.

Step		Description	
$(2.4 \times 10^3) \times (7.1 \times 10^3)$		Original expression	
1.	$= 2.4 \times 7.1 \times 10^3 \times 10^3$	**A.**	**Write in standard form.**
2.	$= (2.4 \times 7.1) \times (10^3 \times 10^3)$	**B.**	**Product of Powers Property**
3.	$= 17.04 \times 10^6$	**C.**	**Write in scientific notation.**
4.	$= 1.704 \times 10^1 \times 10^6$	**D.**	**Commutative Property of Multiplication**
5.	$= 1.704 \times 10^7$	**E.**	**Simplify.**
6.	$= 17{,}040{,}000$	**F.**	**Associative Property of Multiplication**

10.7 Operations in Scientific Notation (continued)

Does this procedure work when the numbers have different powers of 10? Justify your answer by using this procedure to evaluate the products below.

- $(1.9 \times 10^2) \times (2.3 \times 10^5) =$

- $(8.4 \times 10^6) \times (5.7 \times 10^{-4}) =$

4 ACTIVITY: Using Scientific Notation to Estimate

Work with a partner. A person normally breathes about 6 liters of air per minute. The life expectancy of a person in the United States at birth is about 80 years. Use scientific notation to estimate the total amount of air a person born in the United States breathes over a lifetime.

What Is Your Answer?

5. IN YOUR OWN WORDS How can you perform operations with numbers written in scientific notation?

6. Use a calculator to evaluate the expression. Write your answer in scientific notation and in standard form.

a. $(1.5 \times 10^4) + (6.3 \times 10^4)$

b. $(7.2 \times 10^5) - (2.2 \times 10^3)$

c. $(4.1 \times 10^{-3}) \times (4.3 \times 10^{-3})$

d. $(4.75 \times 10^{-6}) \times (1.34 \times 10^7)$

Name _____ Date _____

10.7 Practice

For use after Lesson 10.7

Find the sum or difference. Write your answer in scientific notation.

1. $(2 \times 10^4) + (7.2 \times 10^4)$

2. $(3.2 \times 10^{-2}) + (9.4 \times 10^{-2})$

3. $(6.7 \times 10^5) - (4.3 \times 10^5)$

4. $(8.9 \times 10^{-3}) - (1.9 \times 10^{-3})$

Find the product or quotient. Write your answer in scientific notation.

5. $(6 \times 10^8) \times (4 \times 10^6)$

6. $(9 \times 10^{-3}) \times (9 \times 10^{-3})$

7. $(8 \times 10^3) \div (2 \times 10^2)$

8. $(2.34 \times 10^5) \div (7.8 \times 10^5)$

9. How many times greater is the radius of a basketball than the radius of a marble?

Radius $= 1.143 \times 10^1$ cm

Radius $= 5 \times 10^{-1}$ cm