Savings Yogi decided to start saving money by putting a penny in his piggy bank, then doubling the amount he saves each week. Use the questions below to find how much money Yogi will save in 8 weeks.

1. Complete the table below to find the amount Yogi saved each week and the total amount in his piggy bank.

Week	0	1	2	3	4	5	6
Weekly Savings	1¢	2¢	4¢	8¢	16¢	32¢	64¢
Total Savings	1¢	3¢	7¢	15¢	31¢	63¢	$1.27

2. How many 2s are multiplied to find his savings in Week 4? **4**

   Week 5? **5**

3. How much money will Yogi save in Week 8? **$2.56**

4. Continue the table to find when he will have enough to buy a pair of shoes for $80. **after week 12**

Week	7	8	9	10	11	12
Weekly Savings	$1.28	$2.56	$5.12	$10.24	$20.48	$40.96
Total Savings	$2.55	$5.11	$10.23	$20.47	$40.95	$81.91

numbers in different ways?

Vocabulary

power
base $16 = 2^4$
exponent $32 = 2^5$

Common Core State Standards

Content Standards
8.EE.1

MP Mathematical Practices
1, 3, 4, 8

$16 \times 2 = 32$

8×2

$4 \times 2 \times 2$

$2 \times 2 \times 2 \times 2$

15

Examples

Tutor

Write each expression using exponents.

1. $(-2) \cdot (-2) \cdot (-2) \cdot 3 \cdot 3 \cdot 3 \cdot 3$

The base -2 is a factor 3 times, and the base 3 is a factor 4 times.

$(-2) \cdot (-2) \cdot (-2) \cdot 3 \cdot 3 \cdot 3 \cdot 3 = (-2)^3 \cdot 3^4$

2. $a \cdot b \cdot b \cdot a \cdot b$

Use the properties of operations to rewrite and group like bases together. The base a is a factor 2 times, and the base b is a factor 3 times.

$a \cdot b \cdot b \cdot a \cdot b = a \cdot a \cdot b \cdot b \cdot b$

$= a^2 \cdot b^3$

Got it? Do these problems to find out.

a. $\dfrac{1}{2} \cdot \dfrac{1}{2} \cdot \dfrac{1}{2} \cdot \dfrac{1}{2}$ **b.** $4 \cdot 4 \cdot 4 \cdot 5 \cdot 5$ **c.** $m \cdot m \cdot n \cdot n \cdot m$

Show your work.

a. $\left(\dfrac{1}{2}\right)^4$ _____

b. $4^3 \cdot 5^2$ _____

c. $m^3 \cdot n^2$ _____

3. Evaluate $\left(-\frac{2}{3}\right)^4$.

$\left(-\frac{2}{3}\right)^4 = \left(-\frac{2}{3}\right)\cdot\left(-\frac{2}{3}\right)\cdot\left(-\frac{2}{3}\right)\cdot\left(-\frac{2}{3}\right)$ — Write the power as a product.

$= \frac{16}{81}$ — Multiply.

Remember that to evaluate an expression means to find its value.

Show your work.

Got it? Do these problems to find out.

d. 4^4 e. $(-2)^6$ f. $\left(\frac{1}{5}\right)^3$

d. **256**

e. **64**

f. $\frac{1}{125}$

Real World Example

Tutor

4. The deck of a skateboard has an area of about $2^5 \cdot 7$ square inches. What is the area of the skateboard deck?

$2^5 \cdot 7 = 2\cdot2\cdot2\cdot2\cdot2\cdot7$ — Write the power as a product.

$= (2\cdot2\cdot2\cdot2\cdot2)\cdot7$ — Associative Property

$= 32 \cdot 7$ or 224 — Multiply.

The area of the skateboard deck is about 224 square inches.

Got it? Do this problem to find out.

g. A school basketball court has an area of $2^3 \cdot 3 \cdot 5^2 \cdot 7$ square feet. What is the area of

g. **4,200 ft²**

h. **17** _____

Show your work.

i. **125** _____

j. **715** _____

Got it? Do these problems to find out.

Evaluate each expression if $c = -4$ and $d = 9$.

h. $c^3 + d^2$ i. $(c + d)^3$ j. $d^3 - (c^2 - 2)$

Check ✓

Guided Practice

Write each expression using exponents. (Examples 1 and 2)

1. $(-11)(-11)(-11) =$ **$(-11)^3$**

2. $2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3 =$ **$2^3 \cdot 3^3$**

3. $r \cdot s \cdot r \cdot r \cdot s \cdot s \cdot r \cdot r =$ **$r^5 \cdot s^3$**

Evaluate each expression. (Example 3)

4. $2^6 =$ **64**

5. $(-4)^4 =$ **256**

6. $\left(\frac{1}{7}\right)^3 =$ **$\frac{1}{343}$**

Glossary | Index | Answers: On | Off

7. The table shows the average weights of some endangered mammals. What is the weight of each animal? (Example 4)

Animal	Weight (lb)
Black bear	$2 \cdot 5^2 \cdot 7$
Key deer	$3 \cdot 5^2$
Panther	$2^3 \cdot 3 \cdot 5$

black bear: 350 lb; key deer: 75 lb; panther: 120 lb

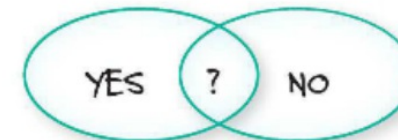Evaluate each expression if $x = 2$ and $y = 10$. (Examples 5 and 6)

8. $x^2 + y^4 =$ **10,004**

9. $(x^2 + y)^3 =$ **2,744**

10. **Building on the Essential Question** How can I write repeated multiplication using powers? **The repeated factor is the base. The number of times it repeats is the exponent.**

Rate Yourself!

Are you ready to move on? Shade the section that applies.

YES ? NO

For more help, go online to access a Personal Tutor.

Tutor

Independent Practice

Go online for Step-by-Step Solutions

Write each expression using exponents. (Examples 1 and 2)

1. $(-5)(-5)(-5)(-5) = $ **$(-5)^4$**

2. $3 \cdot 3 \cdot 5 \cdot q \cdot q \cdot q = $ **$3^2 \cdot 5 \cdot q^3$**

3. $m \cdot m \cdot m \cdot m \cdot m = $ **m^5**

Evaluate each expression. (Example 3)

4. $(-9)^4 = $ **6,561**

5. $\left(\dfrac{1}{3}\right)^4 = $ **$\dfrac{1}{81}$**

6. $\left(\dfrac{5}{7}\right)^3 = $ **$\dfrac{125}{343}$**

7 In the United States, nearly $8 \cdot 10^9$ text messages are sent every month. About how many text messages is this?

(Example 4) **8,000,000,000 or 8 billion**

Text Message
LOL.
TTYL
Select

7 In the United States, nearly $8 \cdot 10^9$ text messages are sent every month. About how many text messages is this?

(Example 4) **8,000,000,000 or 8 billion**

8. Interstate 70 stretches almost $2^3 \cdot 5^2 \cdot 11$ miles across the United States. About how many miles long is Interstate 70?

(Example 4) **2,200 mi**

Evaluate each expression. (Examples 5 and 6)

9 $g^5 - h^3$ if $g = 2$ and $h = 7$ **−311**

10. $c^2 + d^3$, if $c = 8$ and $d = -3$ **37**

11. $a^2 \cdot b^6$ if $a = \dfrac{1}{2}$ and $b = 2$ **16**

12. $(r - s)^3 + r^2$ if $r = -3$ and $s = -4$ **10**

Exercises a–d.

The metric system is based on powers of 10. For example, one kilometer is equal to 1,000 meters or 10^3 meters. Write each measurement in meters as a power of 10.

a. hectometer (100 meters) 10^2

b. megameter (1,000,000 meters) 10^6

c. gigameter (1,000,000,000 meters) 10^9

d. petameter (1,000,000,000,000,000 meters) 10^{15}

d. petameter (1,000,000,000,000,000 meters) $\underline{10^{15}}$

H.O.T. Problems Higher Order Thinking

14. **MP Identify Structure** Write an expression with an exponent that has a value between 0 and 1. **Sample answer:** $\left(\dfrac{1}{2}\right)^2$

15. **MP Identify Repeated Reasoning** Describe the following pattern: $3^4 = 81, 3^3 = 27, 3^2 = 9, 3^1 = 3$. Then use a similar pattern to predict the value of 2^{-1}. **Sample answer: As the exponent decreases by 1, the simplified answer is divided by 3;** $\dfrac{1}{2}$

16. **MP Reason Abstractly** Simplify the expressions below to develop a rule for multiplying powers with the same base.

$2^2 \cdot 2^3 = 32$ or $2^{\boxed{5}}$ $\qquad$ $3 \cdot 3^2 = 27$ or $3^{\boxed{3}}$

$4^3 \cdot 4 = 256$ or $4^{\boxed{4}}$ $\qquad$ $x^2 \cdot x^3 = x^{\boxed{5}}$

Sample answer: Keep the bases the same, and add the exponents.