Interactive Classroom

Glencoe McGraw-Hill

Pre-Algebra

Chapter 4
Factors and Fractions

Click the mouse button or press the space bar to continue.

Copyright © by The McGraw-Hill Companies, Inc.

Chapter Menu

Lesson Menu

Main Ideas

- Write expressions using exponents.
- Evaluate expressions containing exponents.

New Vocabulary

- factor
- base
- exponent
- power

EXAMPLE Write Expressions Using Exponents

1 A. Write 6 ● 6 ● 6 ● 6 using exponents.

Answer: The base is 6. It is a factor 4 times, so the exponent is 4.

$6 \bullet 6 \bullet 6 \bullet 6 = 6^4$

EXAMPLE 1 Write Expressions Using Exponents

B. Write *p* using exponents.

Answer: The base is *p*. It is a factor 1 time, so the exponent is 1.

$p = p^1$

EXAMPLE 1 Write Expressions Using Exponents

C. Write (–1)(–1)(–1) using exponents.

Answer: The base is –1. It is a factor 3 times, so the exponent is 3.

$(-1)(-1)(-1) = (-1)^3$

EXAMPLE 1 Write Expressions Using Exponents

D. Write $(5x + 1)(5x + 1)$ using exponents.

Answer: The base is $5x + 1$. It is a factor 2 times, so the exponent is 2.

$(5x + 1)(5x + 1) = (5x + 1)^2$

EXAMPLE 1 Write Expressions Using Exponents

E. Write $\frac{1}{2} \cdot x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y$ using exponents.

First, group the factors with like bases. Then write using exponents.

$$\frac{1}{2} \cdot x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y = \frac{1}{2} \cdot (x \cdot x \cdot x \cdot x) \cdot (y \cdot y \cdot y)$$

$x \cdot x \cdot x \cdot x = x^4$ and
$y \cdot y \cdot y = y^3$

Answer: $= \frac{1}{2} x^4 y^3$

CHECK Your Progress

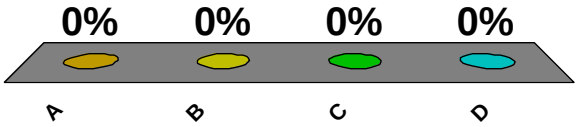
1 **A. Write the expression using exponents.**
$3 \bullet 3 \bullet 3 \bullet 3 \bullet 3 \bullet 3$

A. $3^2 \bullet 3^3$

B. $3 \bullet 6$

C. 3^5

D. 3^6



CheckPoint

CHECK Your Progress

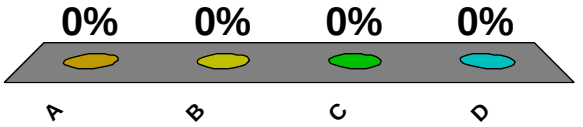
1 **B.** Write the expression using exponents. $m \bullet m \bullet m$

A. $3m$

B. m^3

C. $m \bullet m^3$

D. m^4



CheckPoint

CHECK Your Progress

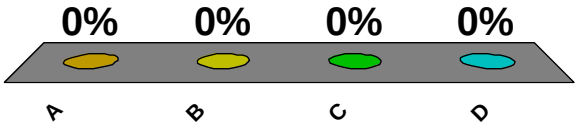
1 **C. Write the expression using exponents.**
(–6)(–6)(–6)(–6)

A. 6^4

B. -6^4

C. $-6 \bullet 4$

D. $(-6)^4$



CheckPoint

CHECK Your Progress

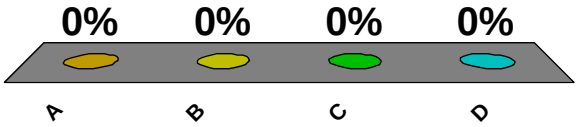
1 **D. Write the expression using exponents.**
$(4 - 2x)(4 - 2x)$

A. $(4 - 2x)^2$

B. $4 - 2x^2$

C. $2(4 - 2x)$

D. $4^2 - 2x^2$



CheckPoint

CHECK Your Progress

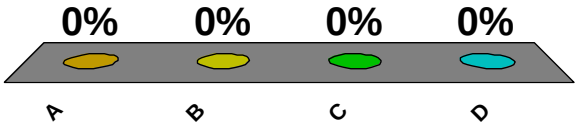
1 **E. Write the expression using exponents.**
$9 \bullet a \bullet a \bullet a \bullet b \bullet b \bullet b \bullet b \bullet b$.

A. $9ab^5$

B. $9a^3b^5$

C. $(9ab)^8$

D. $9a^8b^8$



CheckPoint

CONCEPT SUMMARY — Order of Operations

	Words	Example
Step 1	Simplify the expressions inside grouping symbols first.	$(3 + 4)^2 + 5 \cdot 2 = 7^2 + 5 \cdot 2$
Step 2	Evaluate all powers.	$= 49 + 5 \cdot 2$
Step 3	Do all multiplications or divisions in order from left to right.	$= 49 + 10$
Step 4	Do all additions or subtractions in order from left to right.	$= 59$

EXAMPLE 2 Evaluate Numeric Expressions

A. Evaluate 4^2.

$4^2 = 4 \bullet 4$ 4 is a factor two times.

$= 16$ Multiply.

Answer: 16

EXAMPLE 2 Evaluate Numeric Expressions

B. Evaluate $2 \bullet 3^2$.

$2 \bullet 3^2 = 2 \bullet 9$ 3 is a factor two times.

$= 18$ Multiply.

Answer: 18

CHECK Your Progress

2 Evaluate $5 \bullet 4^2$.

A. 8

B. 20

C. 80

D. 81

0%

A B C D

CheckPoint

EXAMPLE 3 Evaluate Algebraic Expressions

A. Evaluate $r^3 - 3$ if $r = -2$.

$r^3 - 3 = (-2)^3 - 3$ Replace r with -2.

$= (-2)(-2)(-2) - 3$ -2 is a factor 3 times.

$= -8 - 3$ or -11 Multiply. Then subtract.

Answer: -11

EXAMPLE 3 Evaluate Algebraic Expressions

B. Evaluate $x(y + 2)^2$ if $x = 2$ and $y = -2$.

$x(y + 2)^2 = 2(-2 + 2)^2$	Replace x with 2 and y with –2.
$= 2(0)^2$	Simplify the expression inside the parentheses.
$= 2(0)$ or 0	Evaluate $(0)^2$. Then simplify.

Answer: 0

CHECK Your Progress

3 **A. Evaluate the expression $100 - x^4$ if $x = 2$.**

A. 92

B. 68

C. 98

D. 84

0%

A B C D

CHECK Your Progress

3 **B.** Evaluate the expression $m(5 - n)^3$ if $m = -3$ and $n = 3$.

A. 216

0%

B. 24

C. –24

D. –18

A B C D

CheckPoint

End of the Lesson

Click the mouse button to return to the Chapter Menu.

Lesson Menu

Main Ideas

- Write the prime factorizations of composite numbers.
- Factor monomials.

New Vocabulary

- prime number
- composite number
- prime factorization
- factor tree
- monomial
- factor

EXAMPLE Identify Numbers as Prime or Composite

1 A. Determine whether 31 is *prime* or *composite*.

Find factors of 31 by listing the whole number pairs whose product is 31.

$31 = 1 \times 31$

The number 31 has only two factors.

Answer: Therefore, 31 is a prime number.

EXAMPLE 1 Identify Numbers as Prime or Composite

B. Determine whether 36 is *prime* or *composite*.

Find factors of 36 by listing the whole number pairs whose product is 36.

$36 = 1 \times 36$
$36 = 2 \times 18$
$36 = 3 \times 12$
$36 = 4 \times 9$
$36 = 6 \times 6$

The factors of 36 are 1, 2, 3, 4, 6, 9, 12, 18, and 36.

Answer: Since the number has more than two factors, it is composite.

CHECK Your Progress

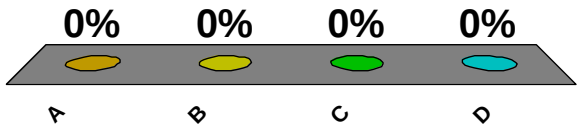
1 **A. Determine whether 49 is *prime* or *composite*.**

A. prime

B. composite

C. neither

D. prime and composite



CheckPoint

CHECK Your Progress

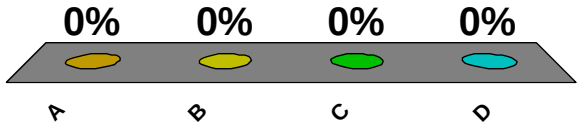
1 **B.** Determine whether 29 is *prime* or *composite*.

A. prime

B. composite

C. neither

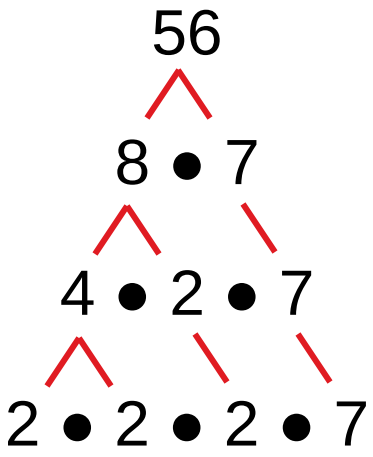
D. prime and composite



CheckPoint

EXAMPLE Write Prime Factorization

2 **Write the prime factorization of 56.**



$56 = 8 \bullet 7$

$8 = 4 \bullet 2$

$4 = 2 \bullet 2$

The prime factorization is complete because 2 and 7 are prime numbers.

Answer: The prime factorization of 56 is $2 \bullet 2 \bullet 2 \bullet 7$ or $2^3 \bullet 7$.

CHECK Your Progress

2 Write the prime factorization of 72.

A. 2^6

B. $2^2 \bullet 3^3$

C. $2^3 \bullet 3^2$

D. $3^2 \bullet 7$

0%

A B C D

CheckPoint

EXAMPLE 3 Factor Monomials

A. Factor the monomial $16p^2q^4$.

$16p^2q^4 = 2 \bullet 2 \bullet 2 \bullet 2 \bullet p^2 \bullet q^4$

$16 = 2 \bullet 2 \bullet 2 \bullet 2$

$16p^2q^4 = 2 \bullet 2 \bullet 2 \bullet 2 \bullet p \bullet p \bullet q \bullet q \bullet q \bullet q$

$p^2 \bullet q^4 = p \bullet p \bullet q \bullet q \bullet q \bullet q$

Answer: $16p^2q^4 = 2 \bullet 2 \bullet 2 \bullet 2 \bullet p \bullet p \bullet q \bullet q \bullet q \bullet q$

EXAMPLE 3 Factor Monomials

B. Factor the monomial $-21x^2y$.

$21x^2y = -1 \bullet 3 \bullet 7 \bullet x^2 \bullet y$

$21 = 1 \bullet 3 \bullet 7$

$21x^2y = -1 \bullet 3 \bullet 7 \bullet x \bullet x \bullet y$

$x^2 \bullet y = x \bullet x \bullet y$

Answer: $21x^2y = -1 \bullet 3 \bullet 7 \bullet x \bullet x \bullet y$

EXAMPLE Factor Monomials

3 **C. Factor the monomial $-39a^3bc^2$.**

$-39a^3bc^2 = -1 \bullet 3 \bullet 13 \bullet a^3 \bullet b \bullet c^2$ $-39 = -1 \bullet 3 \bullet 13$

$-39a^3bc^2 = -1 \bullet 3 \bullet 13 \bullet a \bullet a \bullet a \bullet b \bullet c \bullet c$

$a^3 \bullet b \bullet c^2 = a \bullet a \bullet a \bullet b \bullet c \bullet c$

Answer: $-39a^3bc^2 = -1 \bullet 3 \bullet 13 \bullet a \bullet a \bullet a \bullet b \bullet c \bullet c$

CHECK Your Progress

3 **A. Factor the monomial $12a^3b$.**

A. $3 \bullet 4 \bullet a \bullet a \bullet a \bullet b$

B. $12 \bullet a \bullet a \bullet a \bullet b$

C. $2 \bullet 2 \bullet 3 \bullet a^3 \bullet b$

D. $2 \bullet 2 \bullet 3 \bullet a \bullet a \bullet a \bullet b$

0%

A B C D

CHECK Your Progress

3 **B.** Factor the monomial $-18mn^2$.

A. $-18 \bullet m \bullet n \bullet n$

B. $-1 \bullet 2 \bullet 3 \bullet 3 \bullet m \bullet n \bullet n$

C. $-1 \bullet 2 \bullet 9 \bullet m \bullet n^2$

D. $-1 \bullet 2 \bullet 3 \bullet 3 \bullet m \bullet n^2$

0%

A B C D

CheckPoint

End of the Lesson

Click the mouse button to return to the Chapter Menu.

Lesson Menu

Main Ideas

- Find the greatest common factor of two or more numbers or monomials.
- Use the Distributive Property to factor algebraic expressions.

New Vocabulary

- Venn diagram
- greatest common factor

EXAMPLE Find the GCF

1 A. Find the GCF of 16 and 24.

Method 1 List the factors.

factors of 16: 1, 2, 4, 8, 16

factors of 24: 1, 2, 3, 4, 6, 8, 12, 24

Answer: The greatest common factor of 16 and 24 is 8.

EXAMPLE Find the GCF

1 A. Find the GCF of 16 and 24.

Method 2 Use prime factorization.

16: $2 \bullet 2 \bullet 2 \bullet 2$

24: $2 \bullet 2 \bullet 2 \bullet 3$

Common factors of 16 and 24: 2, 2, 2

The GCF is the product of the common prime factors.

$2 \bullet 2 \bullet 2 = 8$

Again, the GCF of 16 and 24 is 8.

Answer: 8

EXAMPLE 1 Find the GCF

B. Find the GCF of 28 and 35.

First, factor each number completely. Then circle the common factors.

28: $2 \bullet 2 \bullet 7$

35: $5 \bullet 7$

The common prime factor is 7.

Answer: The GCF of 28 and 35 is 7.

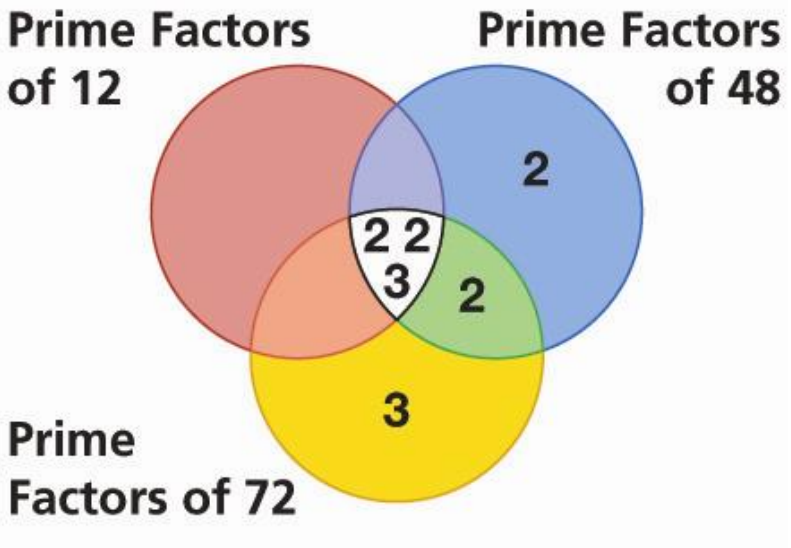
EXAMPLE Find the GCF

1 C. Find the GCF of 12, 48, and 72.

12: 2 • 2 • 3

48: 2 • 2 • 2 • 2 • 3

72: 2 • 2 • 2 • 3 • 3



The common prime factors are 2, 2, and 3.

Answer: The GCF of 12, 48, and 72 is 2 • 2 • 3 or 12.

CHECK Your Progress

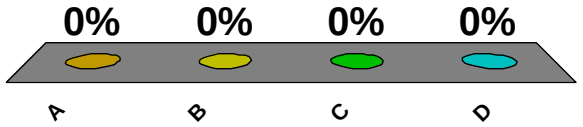
1 A. Find the GCF of 18 and 30.

A. 3

B. 6

C. 2

D. 9



CheckPoint

CHECK Your Progress

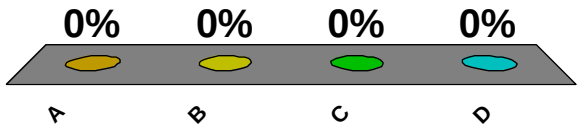
1 **B. Find the GCF of 24 and 32.**

A. 2

B. 6

C. 8

D. 12



CheckPoint

CHECK Your Progress

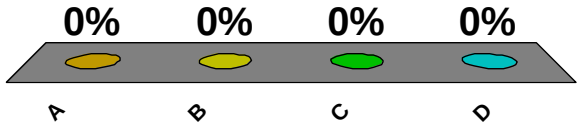
1 **C. Find the GCF of 30, 42, and 60.**

A. 6

B. 3

C. 12

D. 2



CheckPoint

Real-World EXAMPLE

2 **A. BAKE SALE** **Parents donated 150 chocolate chip cookies and 120 molasses cookies for a school bake sale. If the cookies are arranged on plates, and each plate has the same number of chocolate chip cookies and the same number of molasses cookies, what is the largest number of plates possible?**

Find the GCF of 150 and 120.

150: 2 • 3 • 5 • 5

120: 2 • 2 • 2 • 3 • 5

The common prime factors are 2, 3, and 5.

Real-World EXAMPLE

2 The GCF of 150 and 120 is 2 ● 3 ● 5 or 30.

Answer: So, 30 plates are possible.

Real-World EXAMPLE

2 **B. BAKE SALE** **Parents donated 150 chocolate chip cookies and 120 molasses cookies for a school bake sale. How many chocolate chip and molasses cookies will be on each plate?**

Chocolate chip: $150 \div 30 = 5$

Molasses: $120 \div 30 = 4$

Answer: So, each plate will have 5 chocolate chip cookies and 4 molasses cookies.

CHECK Your Progress

2 **A. APPLES** There are 96 red apples and 72 green apples to be placed in baskets. If the apples are arranged in baskets, and each basket has the same number of red apples and the same number of green apples, what is the largest number of baskets possible?

0%

A. 4 baskets

B. 12 baskets

C. 6 baskets

D. 24 baskets

A B C D

CheckPoint

CHECK Your Progress

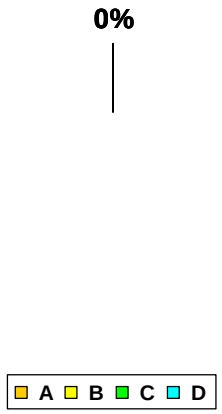
2 **B. APPLES** There are 96 red apples and 72 green apples to be placed in baskets. How many red apples and green apples will be in each basket?

A. 8 red apples, 6 green apples

B. 4 red apples, 3 green apples

C. 24 red apples, 18 green apples

D. 16 red apples, 12 green apples



EXAMPLE Find the GCF of Monomials

3 **Find the GCF of $18x^3y^2$ and $42xy^2$.**

Completely factor each expression.

$18x^3y^2 = 2 \bullet 3 \bullet 3 \bullet x \bullet x \bullet x \bullet y \bullet y$

$42xy^2 = 2 \bullet 3 \bullet 7 \bullet x \bullet y \bullet y$

Circle the common factors.

Answer: The GCF of $18x^3y^2$ and $42xy^2$ is $2 \bullet 3 \bullet x \bullet y \bullet y$ or $6xy^2$.

CHECK Your Progress

3 Find the GCF of $32mn^4$ and $80m^3n^2$.

A. $4mn^2$

B. $16mn^2$

C. $16m^2n^4$

D. $8mn^2$

0%

A B C D

EXAMPLE Factor Expressions

4 **Factor $3x + 12$.**

First, find the GCF of $3x$ and 12.

$3x = 3 \bullet x$

$12 = 2 \bullet 2 \bullet 3$ The GCF is 3.

Now, write each term as a product of the GCF and its remaining factors.

$3x + 12 = 3(x) + 3(4)$

$= 3(x + 4)$ Distributive Property

Answer: $3x + 12 = 3(x + 4)$

CHECK Your Progress

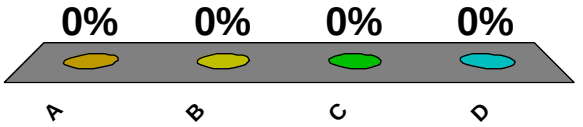
4 Factor $4x + 20$.

A. $2(2x + 10)$

B. $4(x + 20)$

C. $4(x + 5)$

D. $2(x + 10)$



CheckPoint

End of the Lesson

Click the mouse button to return to the Chapter Menu.

Lesson Menu

Main Ideas

- Simplify fractions using the GCF.
- Simplify algebraic fractions.

New Vocabulary

- simplest form
- algebraic fraction

EXAMPLE Simplify Fractions

1 **Write $\frac{16}{24}$ in simplest form.**

$16 = 2 \bullet 2 \bullet 2 \bullet 2$ Factor the numerator.

$24 = 2 \bullet 2 \bullet 2 \bullet 3$ Factor the denominator.

The GCF of 16 and 24 is $2 \bullet 2 \bullet 2$ or 8.

$$\frac{16}{24} = \frac{16 \div 8}{24 \div 8}$$ Divide the numerator and denominator by the GCF.

$$= \frac{2}{3}$$ Simplest form

Answer: $\frac{2}{3}$

CHECK Your Progress

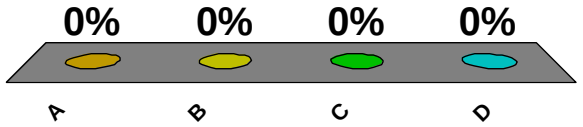
1 Write $\frac{12}{40}$ in simplest form.

A. $\frac{6}{20}$

B. $\frac{3}{10}$

C. $\frac{12}{40}$

D. $\frac{2}{5}$



CheckPoint

EXAMPLE Simplify Fractions

2 Write $\frac{72}{120}$ in simplest form.

$$\frac{72}{120} = \frac{\overset{1}{\cancel{2}} \bullet \overset{1}{\cancel{2}} \bullet \overset{1}{\cancel{2}} \bullet \overset{1}{\cancel{3}} \bullet 3}{\underset{1}{\cancel{2}} \bullet \underset{1}{\cancel{2}} \bullet \underset{1}{\cancel{2}} \bullet \underset{1}{\cancel{3}} \bullet 5}$$

Divide the numerator and the denominator by the GCF, 2 ● 2 ● 2 ● 3.

$$= \frac{3}{5}$$

Simplify.

Answer: $\frac{3}{5}$

Concepts in MOtion
Interactive Lab:
Representing Fractions
Click here to view!

CHECK Your Progress

2 Write $\frac{48}{80}$ in simplest form.

A. $\frac{24}{40}$

B. $\frac{6}{10}$

C. $\frac{48}{80}$

D. $\frac{3}{5}$

0%

A B C D

CheckPoint

Standardized Test EXAMPLE

3 250 pounds is what part of 1 ton?

A $\frac{1}{10}$ **B** $\frac{1}{8}$ **C** $\frac{1}{4}$ **D** $\frac{1}{2}$

Read the Test Item

The phrase what part indicates a relationship that can be written as a fraction. You need to write a fraction comparing 250 pounds to the number of pounds in 1 ton.

Solve the Test Item

There are 2000 pounds in 1 ton.

Write the fraction $\frac{250}{2000}$ in simplest form.

Standardized Test EXAMPLE

3 $\frac{250}{2000} = \frac{{}^{1}\cancel{2} \cdot {}^{1}\cancel{5} \cdot {}^{1}\cancel{5} \cdot {}^{1}\cancel{5}}{\cancel{2}_{1} \cdot 2 \cdot 2 \cdot 2 \cdot \cancel{5}_{1} \cdot \cancel{5}_{1} \cdot \cancel{5}_{1}}$

$= \frac{1}{8}$

Divide the numerator and the denominator by the GCF, 2 ● 5 ● 5 ● 5.

Check

You can check whether your answer is correct by solving the problem in a different way. Divide the numerator and denominator by common factors until the fraction is in simplest form.

$\frac{250}{2000} = \frac{25}{200}$

Standardized Test EXAMPLE

3

$$= \frac{5}{40}$$

$$= \frac{1}{8}$$

Answer : So, 250 pounds is $\frac{1}{8}$ of a ton. The answer is B.

CHECK Your Progress

3 80 feet is what part of 40 yards?

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

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

C. $\frac{3}{40}$

D. $\frac{1}{3}$

0%

A B C D

EXAMPLE Simplify Algebraic Fractions

4 A. Simplify $\dfrac{20m^3n^2}{65mn}$.

$$\frac{20m^3n^2}{65mn} = \frac{2 \bullet 2 \bullet \cancel{5}^{1} \bullet \cancel{m}^{1} \bullet m \bullet m \bullet \cancel{n}^{1} \bullet n}{\cancel{5}_{1} \bullet 13 \bullet \cancel{m}_{1} \bullet \cancel{n}_{1}}$$

Divide the numerator and the denominator by the GCF, $5 \bullet m \bullet n$.

$$= \frac{4m^2n}{13}$$

Simplify.

Answer : $\dfrac{4m^2n}{13}$

CHECK Your Progress

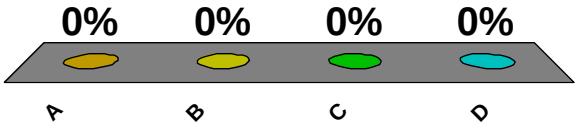
4 **A.** Simplify $\frac{14x^4y^2}{49x^2y^5}$.

A. $\frac{14x^2}{49y^3}$

B. $\frac{2x^2y^3}{7}$

C. $\frac{2x^2}{7y^3}$

D. $\frac{2y^3}{7x^2}$



CheckPoint

EXAMPLE 4 Simplify Algebraic Fractions

B. Simplify $\dfrac{x^3y^2}{x^2y^3}$.

$$\frac{x^3y^2}{x^2y^3} = \frac{\overset{1}{\cancel{x}} \bullet \overset{1}{\cancel{x}} \bullet x \bullet \overset{1}{\cancel{y}} \bullet \overset{1}{\cancel{y}}}{\underset{1}{\cancel{x}} \bullet \underset{1}{\cancel{x}} \bullet \underset{1}{\cancel{y}} \bullet \underset{1}{\cancel{y}} \bullet y}$$

Factor.

$$= \frac{x}{y}$$

Simplify.

Answer: $\dfrac{x}{y}$

CHECK Your Progress

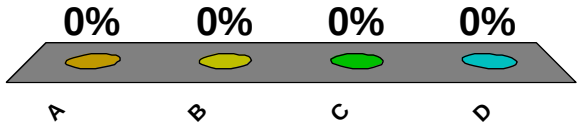
4 B. Simplify $\frac{m^2np^4}{mn^3p^2}$.

A. $\frac{mp^2}{n}$

B. $\frac{p^2}{mn^2}$

C. $\frac{np^2}{m}$

D. $\frac{mp^2}{n^2}$



CheckPoint

End of the Lesson

Click the mouse button to return to the Chapter Menu.

Lesson Menu

Main Ideas

- Multiply monomials.
- Divide monomials.

KEY CONCEPT — Product of Powers

Words Multiply powers with the same base by adding their exponents.

Symbols $a^m \cdot a^n = a^{m+n}$

Example $3^2 \cdot 3^4 = 3^{2+4}$ or 3^6

EXAMPLE Multiply Powers

1 **Find $3^4 \bullet 3^6$.**

$3^4 \bullet 3^6 = 3^{4+6}$ The common base is 3.

$= 3^{10}$ Add the exponents.

Answer: 3^{10}

CHECK Your Progress

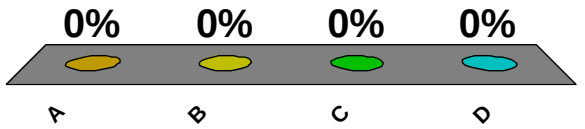
1 Find $4^3 \cdot 4^5$.

A. 4^2

B. 4^8

C. 4^{15}

D. 4^{-2}



CheckPoint

EXAMPLE Multiply Monomials

2 A. Find $y^4 \bullet y$.

$y^4 \bullet y = y^{4+1}$ The common base is y.

$= y^5$ Add the exponents.

Answer: y^5

EXAMPLE Multiply Monomials

2 B. Find $(3p^4)(-2p^3)$.

$(3p^4)(-2p^3) = (3 \bullet -2)(p^4 \bullet p^3)$ Group the coefficients and variables.

$= (-6)(p^{4+3})$ The common base is p.

$= -6p^7$ Add the exponents.

Answer: $-6p^7$

CHECK Your Progress

2 **A. Find the product of $w^2 \cdot w^5$.**

A. w^3

B. w^7

C. w^{10}

D. w^{-3}

0%

A B C D

CheckPoint

CHECK Your Progress

2 B. Find the product of $(-4m^3)(6m^2)$.

A. $2m^5$

B. $-24m^5$

C. $-24m^6$

D. $2m^6$

0%

A B C D

CheckPoint

KEY CONCEPT — Quotient of Powers

Words Divide powers with the same base by subtracting their exponents.

Symbols $\frac{a^m}{a^n} = a^{m-n}$, where $a \neq 0$

Example $\frac{4^5}{4^2} = 4^{5-2}$ or 4^3

Concepts in MOtion

BrainPOP:
Multiplying and Dividing Monomials

Click here to view!

EXAMPLE Divide Powers

3 A. Find $\frac{8^{11}}{8^5}$.

$\frac{8^{11}}{8^5} = 8^{11-5}$ The common base is 8.

$= 8^6$ Subtract the exponents.

Answer: 8^6

EXAMPLE Divide Powers

3 B. Find $\frac{x^{12}}{x}$.

$$\frac{x^{12}}{x} = x^{12-1}$$ The common base is x.

$$= x^{11}$$ Subtract the exponents.

Answer: x^{11}

CHECK Your Progress

3 A. Find $\frac{6^5}{6^3}$.

A. 6^2

B. 6^8

C. 6^{-2}

D. 6^{15}

0%

A B C D

CHECK Your Progress

3 **B.** Find $\frac{r^4}{r^1}$.

A. r^4

B. 1^4

C. r^3

D. r^5

0%

A B C D

Real-World EXAMPLE

4 **FOLDING PAPER** **If you fold a sheet of paper in half, you have a thickness of 2 sheets. Folding again, you have a thickness of 4 sheets. Continue folding in half and recording the thickness. How many times thicker is a sheet that has been folded 4 times than a sheet that has not been folded?**

Write a division expression to compare the thickness.

$$\frac{2^4}{2^0} = 2^{4-0}$$ Subtract the exponents.

$$= 2^4 \text{ or } 16$$

Answer: So, the paper is 16 times thicker.

CHECK Your Progress

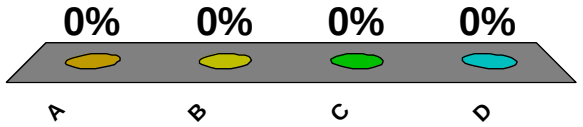
4 **RACING** Car A can run at a speed of 2^8 miles per hour and car B runs at a speed of 2^7 miles per hour. How many times faster is car A than car B?

A. 2^{15}

B. 2

C. 2^{56}

D. 2^2



CheckPoint

End of the Lesson

Click the mouse button to return to the Chapter Menu.

Lesson Menu

Main Ideas

- Write expressions using negative exponents.
- Evaluate numerical expressions containing negative exponents.

KEY CONCEPT — Negative Exponents

Symbols $a^{-n} = \frac{1}{a^n}$, for $a \neq 0$ and any whole number n.

Example $5^{-4} = \frac{1}{5^4}$

EXAMPLE Use Positive Exponents

1 A. Write 3^{-4} using a positive exponent.

$$3^{-4} = \frac{1}{3^4}$$

Definition of negative exponent

Answer: $\frac{1}{3^4}$

EXAMPLE 1 Use Positive Exponents

B. Write m^{-2} using a positive exponent.

$$m^{-2} = \frac{1}{m^2}$$ Definition of negative exponent

Answer: $\frac{1}{m^2}$

CHECK Your Progress

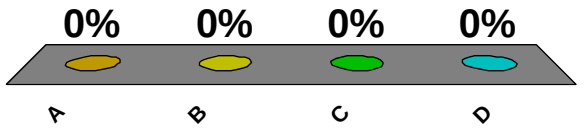
1 **A. Write 5^{-3} using a positive exponent.**

A. 5^3

B. $\frac{1}{3^5}$

C. $\frac{1}{5^3}$

D. 5^2



CheckPoint

CHECK Your Progress

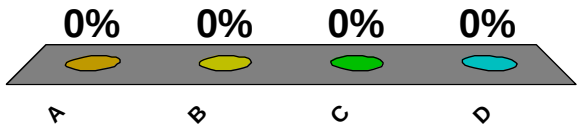
1 **B.** Write y^{-6} using a positive exponent.

A. $\frac{1}{y^6}$

B. y^6

C. $\frac{1}{6}$

D. $\frac{1}{y^5}$



CheckPoint

EXAMPLE Use Negative Exponents

2 **Write $\frac{1}{125}$ as an expression using a negative exponent.**

$$\frac{1}{125} = \frac{1}{5 \cdot 5 \cdot 5}$$

Find the prime factorization of 125.

$$= \frac{1}{5^3}$$

Definition of exponent

$$= 5^{-3}$$

Definition of negative exponent

Answer: 5^{-3}

CHECK Your Progress

2 Write $\frac{1}{32}$ as an expression using a negative exponent.

A. $\frac{1}{2^{-5}}$

B. 2^{-6}

C. 2^{-4}

D. 2^{-5}

0%

A B C D

CheckPoint

Real-World EXAMPLE

3 **ATOM** **An atom is an incredibly small unit of matter. The smallest atom has a diameter of approximately $\frac{1}{10}$ of a nanometer, or** 0.0000000001 **meter. Write the decimal as a fraction and as a power of** 10**.**

$$0.0000000001 = \frac{1}{10,000,000,000}$$

Write the decimal as a fraction.

$$= \frac{1}{10^{10}}$$

$10,000,000,000 = 10^{10}$

Real-World EXAMPLE

3

$= 10^{-10}$ Definition of negative exponent

Answer: 10^{-10}

CHECK Your Progress

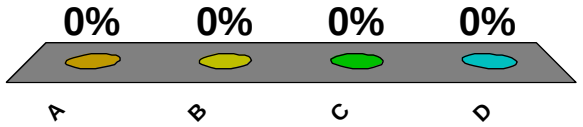
3 **WEATHER** Fog is composed of cloud droplets with a diameter of 0.00001 meter. Write the decimal as a fraction and as a power of ten.

A. $\frac{1}{10,000}$; 10^{-4}

B. $\frac{1}{10,000}$; 10^{-5}

C. $\frac{1}{100,000}$; 10^{-5}

D. $\frac{1}{100,000}$; 10^{-6}



CheckPoint

EXAMPLE Algebraic Expressions with Negative Exponents

4 **Evaluate r^{-2} if $r = -4$.**

$r^{-2} = (-4)^{-2}$ Replace r with -4.

$= \frac{1}{(-4)^2}$ Definition of negative exponent

$= \frac{1}{16}$ Find $(-4)^2$.

Answer: $\frac{1}{16}$

CHECK Your Progress

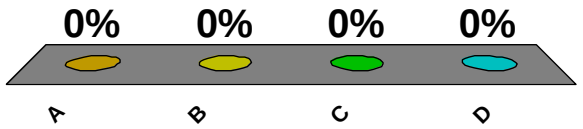
4 Evaluate d^{-3} if $d = 5$.

A. 125

B. $\frac{1}{15}$

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

D. –125



CheckPoint

End of the Lesson

Click the mouse button to return to the Chapter Menu.

Lesson Menu

Main Ideas

- Express numbers in standard form and in scientific notation.
- Compare and order numbers written in scientific notation.

New Vocabulary

- standard form
- scientific notation

KEY CONCEPT — Scientific Notation

Words A number is expressed in scientific notation when it is written as the product of a factor and a power of 10. The factor must be greater than or equal to 1 and less than 10.

Symbols $a \times 10^n$, where $1 \leq a < 10$ and n is an integer

Examples $5{,}000{,}000 = 5.0 \times 10^6$ $\quad$ $0.0005 = 5.0 \times 10^{-4}$

EXAMPLE 1 Express Numbers in Standard Form

A. Express 4.395×10^4 in standard form.

$4.395 \times 10^4 = 4.395 \times 10{,}000$

$= 4.3950$

$10^4 = 10{,}000$

Move the decimal point 4 places to the right.

Answer: 43,950

EXAMPLE 1 Express Numbers in Standard Form

B. Express 6.79×10^{-6} in standard form.

$6.79 \times 10^{-6} = 6.79 \times 0.000001$

$= 0.00000679$

$10^{-6} = 0.000001$

Move the decimal point 6 places to the left.

Answer: 0.00000679

CHECK Your Progress

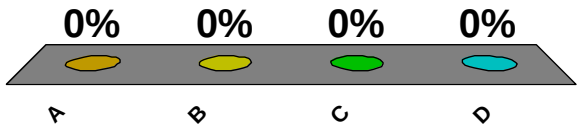
1 **A. Express 2.614×10^6 in standard form.**

A. 2,614,000

B. 261,400

C. 0.000002614

D. 0.002614



CheckPoint

CHECK Your Progress

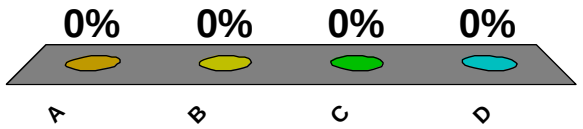
1 **B. Express 8.03×10^{-4} in standard form.**

A. 80,300

B. 8.030

C. 0.000803

D. 0.0803



CheckPoint

EXAMPLE 2 Express Numbers in Scientific Notation

A. Express 800,000 in scientific notation.

$800{,}000 = 8.0 \times 100{,}000$ The decimal point moves 5 places.

$= 8.0 \times 10^5$ The exponent is positive.

Answer: 8.0×10^5

EXAMPLE 2 Express Numbers in Scientific Notation

B. Express 0.0119 in scientific notation.

$0.0119 = 1.19 \times 0.01$ The decimal point moves 2 places.

$= 1.19 \times 10^{-2}$ The exponent is negative.

Answer: 1.19×10^{-2}

CHECK Your Progress

2 **A. Express 65,000 in scientific notation.**

A. 6.5×10^5

B. 6.5×10^{-4}

C. 6.5×10^4

D. 65×10^3

0%

A B C D

CheckPoint

CHECK Your Progress

2 **B. Express 0.00042 in scientific notation.**

A. 42×10^{-5}

B. 4.2×10^{-4}

0%

C. 4.2×10^{4}

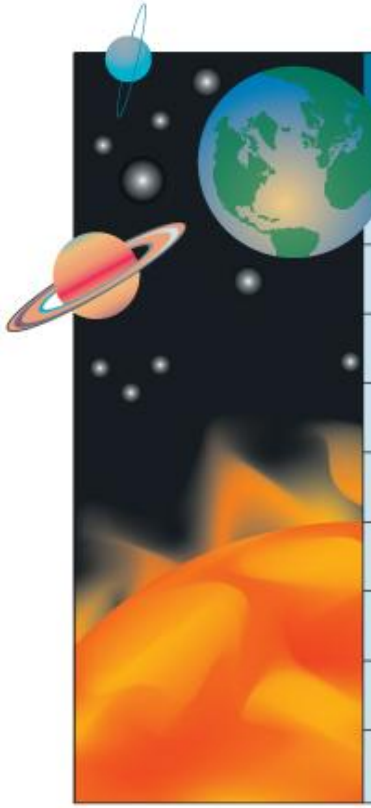
D. 4.2×10^{-3}

A B C D

CheckPoint

Real-World EXAMPLE

3 **SPACE** **The table shows the planets and their distances from the Sun. Estimate how many times farther Pluto is from the Sun than Mercury is from the Sun.**



Planet	Distance from the Sun (km)
Mercury	5.80×10^7
Venus	1.03×10^8
Earth	1.55×10^8
Mars	2.28×10^8
Jupiter	7.78×10^8
Saturn	1.43×10^9
Uranus	2.87×10^9
Neptune	4.50×10^9
Pluto	5.90×10^9

Source: *The World Almanac*

Explore The distance from the Sun to Pluto is 5.90×10^9 km and the distance from the Sun to Mercury is 5.80×10^7 km.

Real-World EXAMPLE

3 **Plan** To find how many times farther Pluto is from the Sun than Mercury is from the Sun, find the ratio of Pluto's distance to Mercury's distance. Since you are estimating, round the distance 5.90×10^9 to 6.0×10^9 and round the distance 5.80×10^7 to 6.0×10^7.

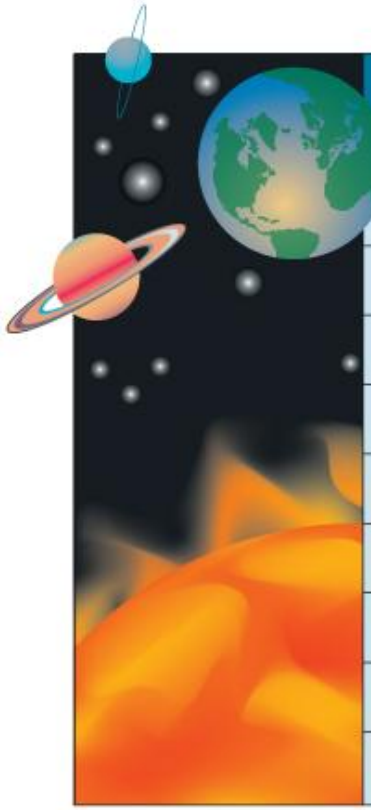
Solve $\dfrac{6.0 \times 10^9}{6.0 \times 10^7} = 1.0 \times 10^2$ Divide.

Answer: So, Pluto is about 1.0×10^2 or 100 times farther from the Sun than Mercury is.

Check Use estimation to check the reasonableness of the results.

CHECK Your Progress

3 **SPACE** Use the table to estimate how many times farther Pluto is from the Sun than Earth is from the Sun.



Planet	Distance from the Sun (km)
Mercury	5.80×10^7
Venus	1.03×10^8
Earth	1.55×10^8
Mars	2.28×10^8
Jupiter	7.78×10^8
Saturn	1.43×10^9
Uranus	2.87×10^9
Neptune	4.50×10^9
Pluto	5.90×10^9

Source: *The World Almanac*

0%

A. 3

B. 30

C. 38

D. 300

A B C D

CheckPoint

Real-World EXAMPLE

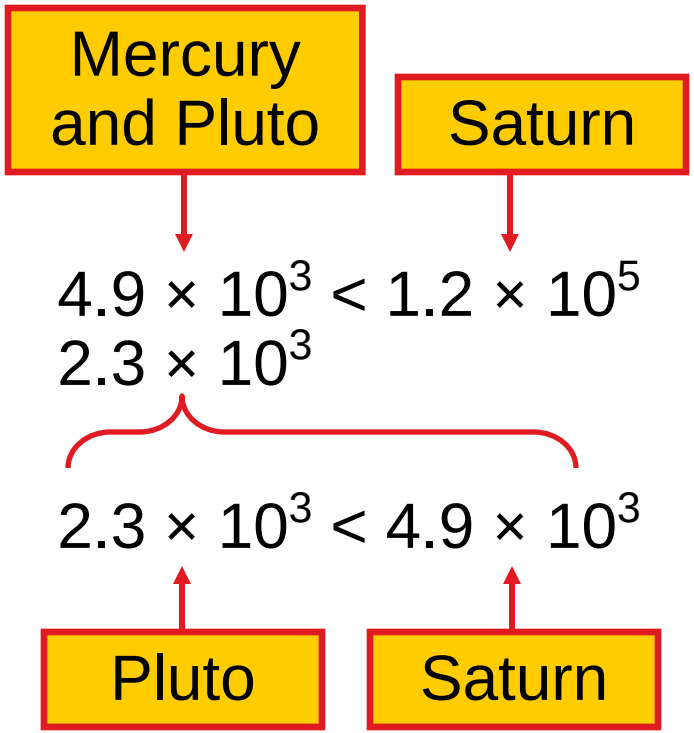
4 **SPACE** **The diameters of Mercury, Saturn, and Pluto are 4.9×10^3 kilometers, 1.2×10^5 kilometers, and 2.3×10^3 kilometers, respectively. List the planets in order of increasing diameter.**

First, order the numbers according to their exponents.

Then, order the numbers with the same exponent by comparing the factors.

Real-World EXAMPLE

4



Compare the factors: $2.3 < 4.9$.

Answer: So, the order is Pluto, Mercury, and Saturn.

CHECK Your Progress

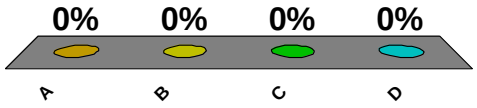
4 Order the numbers 6.21×10^5, 2.35×10^4, 5.95×10^9, and 4.79×10^4 in decreasing order.

A. 2.35×10^4, 4.79×10^4, 6.21×10^5, and 5.95×10^9

B. 6.21×10^5, 5.95×10^9, 4.79×10^4, and 2.35×10^4

C. 2.35×10^4, 4.79×10^4, 5.95×10^9, and 6.21×10^5

D. 5.95×10^9, 6.21×10^5, 4.79×10^4, and 2.35×10^4



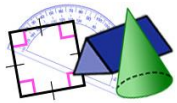
CheckPoint

End of the Lesson

Click the mouse button to return to the Chapter Menu.

Chapter Resources Menu

CheckPoint [Five-Minute Checks]

 [Image Bank]

 [Math Tools]

Concepts in Motion

Interactive Lab  [Representing Fractions]

BrainPOP [Multiplying and Dividing Monomials]

Lesson 4-1 (over Chapter 3)

Lesson 4-2 (over Lesson 4-1)

Lesson 4-3 (over Lesson 4-2)

Lesson 4-4 (over Lesson 4-3)

Lesson 4-5 (over Lesson 4-4)

Lesson 4-6 (over Lesson 4-5)

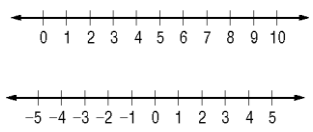
Lesson 4-7 (over Lesson 4-6)

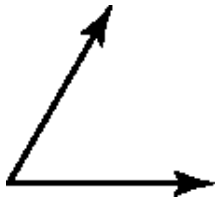
Image Bank

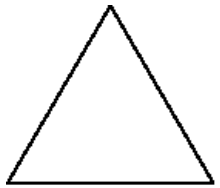
To use the images that are on the following three slides in your own presentation:

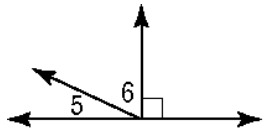
1. Exit this presentation.
2. Open a chapter presentation using a full installation of Microsoft® PowerPoint® in editing mode and scroll to the Image Bank slides.
3. Select an image, copy it, and paste it into your presentation.

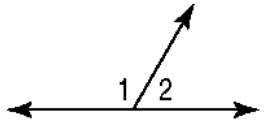
Image Bank

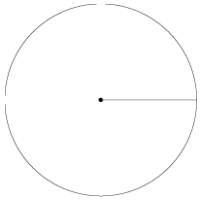

0 1 2 3 4 5 6 7 8 9 10
−5 −4 −3 −2 −1 0 1 2 3 4 5

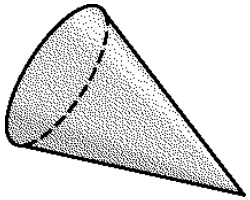


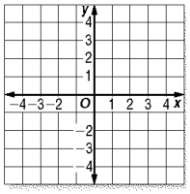


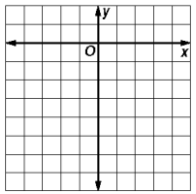

5
6

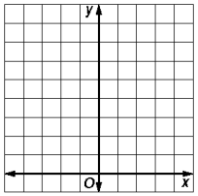

1
2

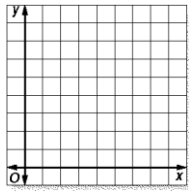


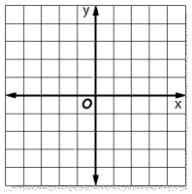


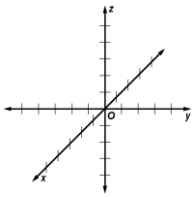

y
4
3
2
1
−4 −3 −2
O
1 2 3 4 x
−2
−3
−4

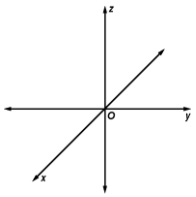

y
O
x

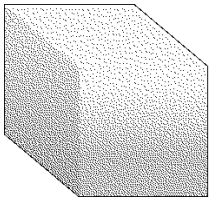

y
O
x

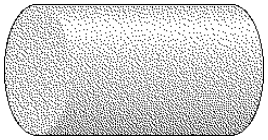

y
O
x

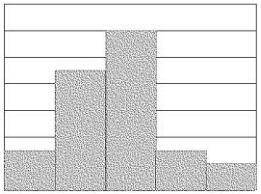

y
O
x

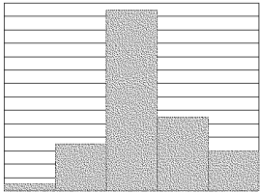

z
O
y
x

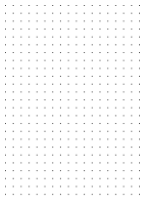

z
O
y
x











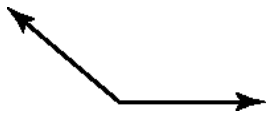
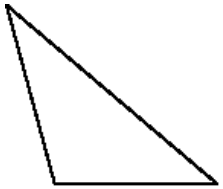
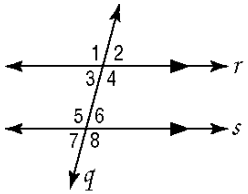
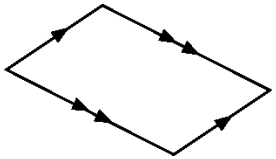
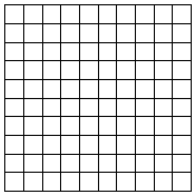


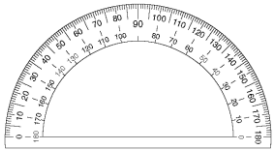
Image Bank

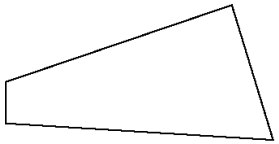


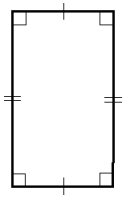


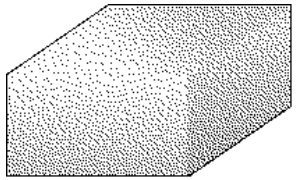


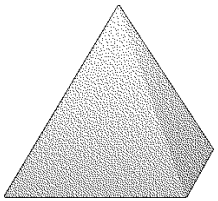


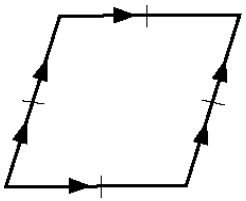


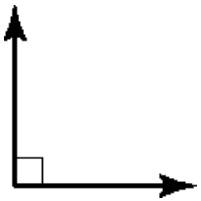


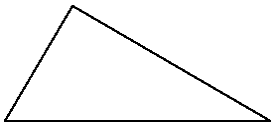


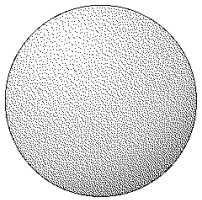


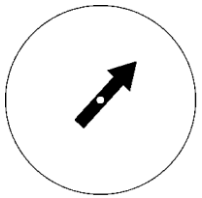


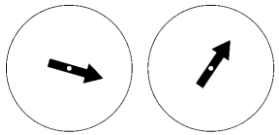


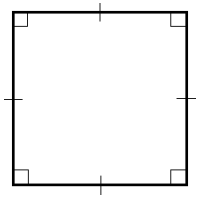












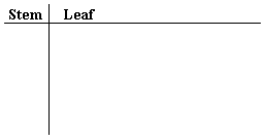
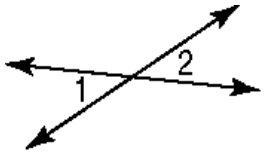
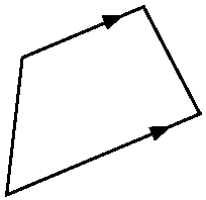
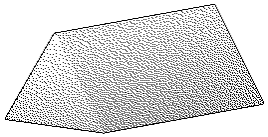
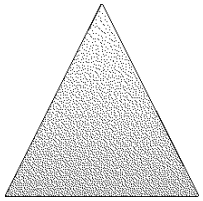


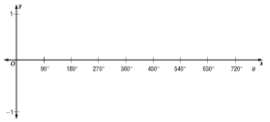
Image Bank

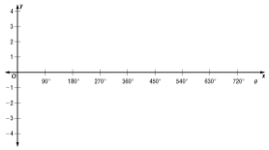


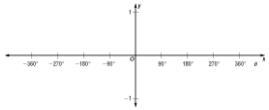


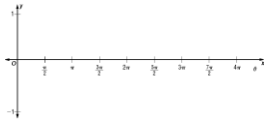


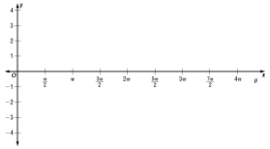












Five-Minute CHECK (over Chapter 3)

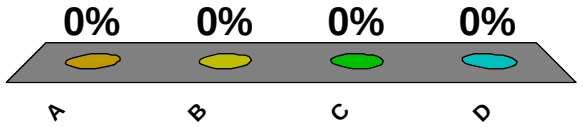
1 Solve $x - 3 = 9$. Check the solution.

A. –6

B. –3

C. 6

D. 12



CheckPoint

Five-Minute CHECK (over Chapter 3)

2 Solve $2x = -16$. Check the solution.

A. –8

B. –14

C. –18

D. –32

0%

A B C D

CheckPoint

Five-Minute CHECK (over Chapter 3)

3 Solve $-12 = \frac{x}{-6}$. Check the solution.

A. –72

B. –18

C. 2

D. 72

0%

A B C D

CheckPoint

Five-Minute CHECK (over Chapter 3)

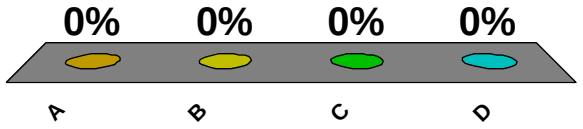
4 Solve $3x - 2 = 13$. Check the solution.

A. $\frac{13}{6}$

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

C. 5

D. 45



CheckPoint

Five-Minute CHECK (over Chapter 3)

5 Janet's age is 3 years less than three times her cousin's age. The sum of their ages is 29. What is Janet's age?

A. 21 years

B. 18 years

C. 11 years

D. 8 years

0%

A B C D

CheckPoint

Five-Minute CHECK (over Chapter 3)

Standardized Test Practice

6 The total cost of a shirt and a pair of jeans is $72. The jeans cost twice as much as the shirt. Which equation could be used to find the cost of the shirts?

A. $2s = 72$ 0%

B. $s + 2s = 72$

C. $2s - s = 72$

D. $s + 3 = 72$

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-1)

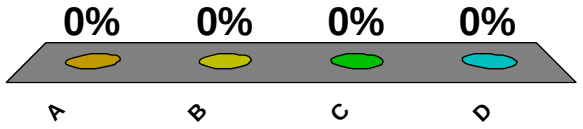
1 Write the expression (–5)(–5)(–5) using exponents.

A. 5^3

B. 5^{-3}

C. $(-5)^3$

D. $-(5)^3$



CheckPoint

Five-Minute CHECK (over Lesson 4-1)

2 Write the expression $m \bullet m \bullet m \bullet m \bullet m \bullet m$ using exponents.

A. m^6

B. $6m$

C. $m + 6$

D. $6m^6$

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-1)

3 Write the expression $4 \bullet a \bullet a \bullet (b + 1)(b + 1)$ using exponents.

A. $4(2a)(2b + 2)$

0%

B. $4a(ab + 1)^2$

C. $4a^2(b + 1)^2$

D. $4a^2 2(b + 1)$

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-1)

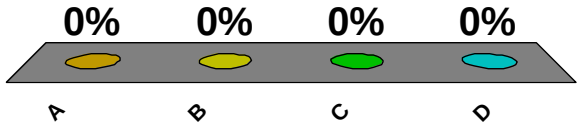
4 Evaluate the expression $a^0 + 13$ for $a = -3$.

A. 16

B. 14

C. 13

D. 10



CheckPoint

Five-Minute CHECK (over Lesson 4-1)

5 Evaluate the expression $(a^2)(b^3)$ for $a = -3$ and $b = 1$.

A. 9

B. 6

C. –6

D. –9

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-1)

Standardized Test Practice

6 Suppose a certain tree triples in height every 4 years. If the initial height of the tree is 4 feet, how tall will the tree be after 16 years?

A. 64 0%

B. 108

C. 256

D. 324

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-2)

1 Determine whether the number 51 is prime or composite.

A. composite

B. prime

0%

0%

A B

CheckPoint

Five-Minute CHECK (over Lesson 4-2)

2 **Determine whether the number 37 is prime or composite.**

A. composite

B. prime

0%

0%

A B

CheckPoint

Five-Minute CHECK (over Lesson 4-2)

3 Write the prime factorization of 75. Use exponents for repeated factors.

A. $(3 \bullet 5)^2$

0%

B. $3 \bullet 2^5$

C. $2 \bullet 3^5$

D. $3 \bullet 5^2$

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-2)

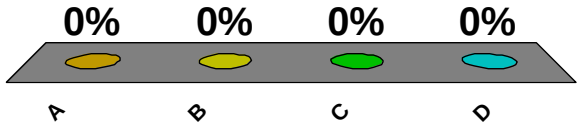
4 Write the prime factorization of 108. Use exponents for repeated factors.

A. $2^2 \bullet 3^3$

B. $2^2 + 3^3$

C. $2^3 + 3^2$

D. $2^3 \bullet 3^2$



CheckPoint

Five-Minute CHECK (over Lesson 4-2)

5 Factor $15x^2$.

A. $3 + 5 + x + x$

B. $3 \bullet 5 \bullet 5 \bullet x$

C. $3 \bullet 5 \bullet x \bullet x$

D. $15 + x^2$

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-2)

Standardized Test Practice

6 Which of the following is $-50x^3y^2$ when factored?

A. $-1 \bullet 2 \bullet 5 \bullet 5 \bullet x \bullet x \bullet x \bullet y \bullet y$

B. $2 \bullet 5 \bullet 5 \bullet x \bullet x \bullet x \bullet y \bullet y$ 0%

C. $-1 \bullet 2 \bullet 5 \bullet 5x^3y^2$

D. $2 \bullet 5 \bullet 5x^3y^2$

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-3)

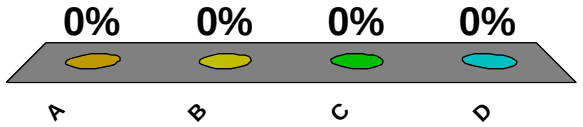
1 Find the GCF of the set of numbers 22, 55.

A. 11

B. 22

C. 55

D. 110



CheckPoint

Five-Minute CHECK (over Lesson 4-3)

2 Find the GCF of the set of numbers 15, 18, 31.

A. 2790

B. 930

C. 3

D. 1

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-3)

3 Find the GCF of the monomials $27xy$, $45y^2$.

A. $27x$

B. $9y$ 0%

C. $9y^2$

D. $27xy^2$

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-3)

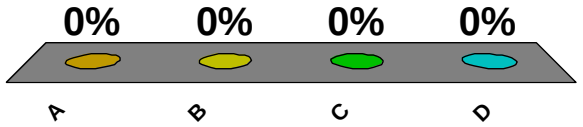
4 Factor the expression $12 + 6a$.

A. $18a$

B. $12 \bullet 6a$

C. $6(2 + a)$

D. $6(a + 12)$



CheckPoint

Five-Minute CHECK (over Lesson 4-3)

5 Factor the expression $18x + 30y$.

A. $6(3x + 5y)$

B. $18x + 30y$

C. $6(3x + 30y)$

D. $6x(3x + 5y)$

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-3)

Standardized Test Practice

6 Find the GCF of $35x^2y$ and $84xy^3$.

A. 7

B. $7xy$

C. $7x^2y^2$

D. $6xy$

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-4)

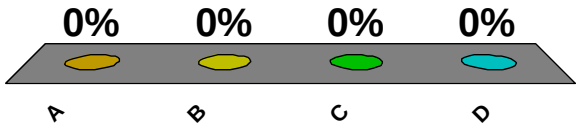
1 Write the fraction $\frac{8}{24}$ in simplest form. If the fraction is already in simplest form, choose *simplified*.

A. $\frac{1}{3}$

B. $\frac{4}{12}$

C. $\frac{3}{8}$

D. simplified



CheckPoint

Five-Minute CHECK (over Lesson 4-4)

2 Write the fraction $\frac{16}{25}$ in simplest form. If the fraction is already in simplest form, choose *simplified*.

A. $\frac{4}{5}$

B. $\frac{2}{5}$

C. $\frac{9}{25}$

D. simplified

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-4)

3 Write the fraction $\frac{42}{56}$ in simplest form. If the fraction is already in simplest form, choose *simplified*.

A. $\frac{6}{7}$ 0%

B. $\frac{3}{4}$

C. $\frac{21}{26}$

D. simplified

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-4)

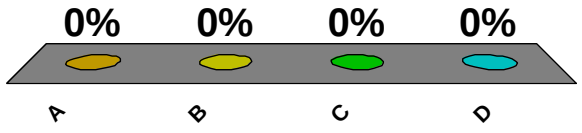
4 Write the fraction $\frac{15x}{18x}$ in simplest form. If the fraction is already in simplest form, choose *simplified*.

A. $\frac{5x}{6}$

B. $\frac{5}{6x}$

C. $\frac{5}{6}$

D. simplified



CheckPoint

Five-Minute CHECK (over Lesson 4-4)

5 Write the fraction $\frac{6a^4}{21a}$ in simplest form. If the fraction is already in simplest form, choose *simplified*.

A. $\frac{2a^3}{7}$

B. $\frac{2a}{7}$

C. $\frac{2a^4}{7}$

D. simplified

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-4)

Standardized Test Practice

6 Which fraction is $\frac{17abc^4}{a^3b}$ written in simplest form?

A. $17a^4c^4$

B. $\frac{17a^2}{c^4}$

C. $\frac{17bc^4}{a^2}$

D. $\frac{17c^4}{a^2}$

0%

A B C D

Five-Minute CHECK (over Lesson 4-5)

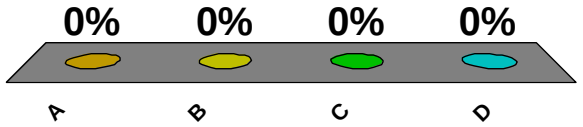
1 Find the product of 10^8 and 10^4 using exponents.

A. 10^2

B. 10^4

C. 10^{12}

D. 10^{32}



CheckPoint

Five-Minute CHECK (over Lesson 4-5)

2 Find the product of a^5 and a^5 using exponents.

A. $(2a)^5$

B. $5a^5$

C. a^{25}

D. a^{10}

0%

A B C D

Five-Minute CHECK (over Lesson 4-5)

3 Find the quotient of $\frac{10^8}{10^4}$ using exponents.

A. 10^4

B. 10^2

C. 10^{12}

D. 10^{32}

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-5)

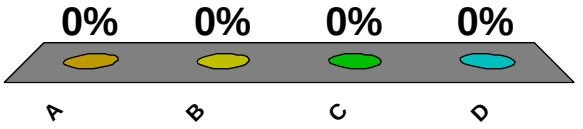
4 Find the quotient of $\frac{x^9}{x^3}$ using exponents.

A. $9x^3$

B. x^{12}

C. x^6

D. x^3



CheckPoint

Five-Minute CHECK (over Lesson 4-5)

5 Find the product of $4y$ and $5y^4$ using exponents.

A. $9y^4$

B. $20y^5$

C. $5y^8$

D. $80y^2$

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-5)

Standardized Test Practice

6 Find the product of n^6 and n^2.

A. n^{12}

B. n^8

C. n^4

D. n^3

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-6)

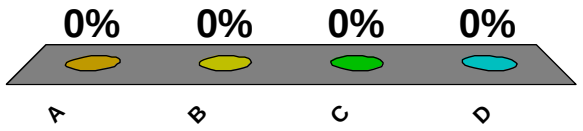
1 Write the expression 2^{-3} using a positive exponent.

A. 2^3

B. 3^2

C. -2^3

D. $\frac{1}{2^3}$



CheckPoint

Five-Minute CHECK (over Lesson 4-6)

2 Write the expression a^{-1} using a positive exponent.

A. $\frac{1}{a}$

B. $\frac{1}{-a}$

C. $-a^1$

D. a^1

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-6)

3 Write the expression $(-5)^{-4}$ using a positive exponent.

A. $\frac{1}{(-5)^4}$ 0%

B. $\frac{1}{5^4}$

C. -5^4

D. 5^4

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-6)

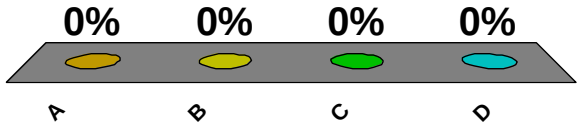
4 Write $\frac{1}{4^5}$ as an expression using a negative exponent other than –1.

A. 4^5

B. -4^5

C. 4^{-5}

D. -4^{-5}



CheckPoint

Five-Minute CHECK (over Lesson 4-6)

5 Write $\frac{1}{49}$ as an expression using a negative exponent other than –1.

A. 49^{1}

B. 49^{-1}

C. -7^{2}

D. 7^{-2}

0%

A B C D

CheckPoint

Five-Minute CHECK (over Lesson 4-6)

Standardized Test Practice

6 Evaluate n^{-4} if $n = -2$.

A. $\frac{1}{16}$

B. $\frac{1}{8}$

C. -8

D. -16

0%

A B C D