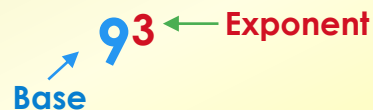


Properties of exponents are rules used to create equivalent expressions.

Properties of exponents can only be used when exponential expressions have the same base.

Exponential Expression

 **9**^{**3**} ← **Exponent**
Base

<u>Multiplying</u> $3^2 \times 3^5$	Keep the <u>base</u> , add the exponents .	$3^2 \times 3^5 = 3^{2+5}$
<u>Dividing</u> $\frac{4^6}{4^3}$	Keep the <u>base</u> , subtract the exponents .	$\frac{4^6}{4^3} = 4^{6-3}$
<u>Raising to an Exponent</u> $(5^4)^3$	Keep the <u>base</u> , multiply the exponents .	$(5^4)^3 = 5^{4 \times 3}$

Exponent rules **CANNOT** be used on the following exponential expressions:

$$5^2 \times 4^3 \qquad \frac{3^4}{4^3}$$

CFU

For which of the following exponential expressions can a property of exponents be used? How do you know?

A $3^4 \times 2^4$

B $4^3 \times 4^2$

How do you know a property of exponents CANNOT be used on the other exponential expression?

What is the difference between the property of exponents for Multiplying and Dividing?

1. Identify exponential expressions with the same base.
2. Determine which property of exponents to apply. Hint: Look at the operation.
3. Create an equivalent expression using properties of exponents.
4. Interpret the exponential expression. "____ is equivalent to ____."

Multiplying

Keep the base,
add the **exponents**

$$3^2 \times 3^5 = 3^{2+5}$$

Dividing

Keep the base,
subtract the **exponents**

$$\frac{4^6}{4^3} = 4^{6-3}$$

Raising to an Exponent

Keep the base,
multiply the **exponents**

$$(5^4)^3 = 5^{4 \times 3}$$

1. $2^2 \times 2^4$

2. $3^2 \times 3^3$

3. $\frac{6^7}{6^4}$

4. $\frac{5^6}{5^2}$

5. $\frac{4^3 \times 4^2}{3^5}$

6. $\frac{2^2 \times 2^3}{5^3}$

7. $\frac{3^2 \times 4^7}{4^4}$

8. $\frac{2^2 \times 5^8}{5^7}$

Properties of exponents are rules used to create equivalent expressions.

Properties of exponents can only be used when exponential expressions have the same base.

Exponential Expression

9 **3** ← Exponent
Base

<u>Multiplying</u> $3^2 \times 3^5$	Keep the <u>base</u> , add the exponents .	$3^2 \times 3^5 = 3^{2+5}$
<u>Dividing</u> $\frac{4^6}{4^3}$	Keep the <u>base</u> , subtract the exponents .	$\frac{4^6}{4^3} = 4^{6-3}$
<u>Raising to an Exponent</u> $(5^4)^3$	Keep the <u>base</u> , multiply the exponents .	$(5^4)^3 = 5^{4 \times 3}$

Exponent rules **CANNOT** be used on the following exponential expressions:

$$5^2 \times 4^3 \qquad \frac{3^4}{4^3}$$

CFU

Which of the following shows the property of exponents correctly used for the expression $(4^3)^2$?

A $4^3 + 2$

B $4^3 \times 2$

C $4^3 - 2$

1. Identify exponential expressions with the same base.
2. Determine which property of exponents to apply. Hint: Look at the operation.
3. Create an equivalent expression using properties of exponents.
4. Interpret the exponential expression. "____ is equivalent to ____."

Multiplying

Keep the base,
add the **exponents**

$$3^2 \times 3^5 = 3^{2+5}$$

Dividing

Keep the base,
subtract the **exponents**

$$\frac{4^6}{4^3} = 4^{6-3}$$

Raising to an Exponent

Keep the base,
multiply the **exponents**

$$(5^4)^3 = 5^{4 \times 3}$$

1. $(3^3)^2$

2. $(5^2)^2$

3. $(2^4)^2 \times 2^2$

4. $(3^2)^2 \times 3^3$

5. $\frac{(5^3)^2}{5^3}$

6. $\frac{(6^5)^2}{6^7}$

Properties of exponents are rules used to create equivalent expressions.

Properties of exponents can only be used when exponential expressions have the same base.

Exponential Expression

Base 9 **Exponent** 3

Raising to a Zero Exponent 7^0	Any base raised to a zero exponent is 1 .	$7^0 = 1$
Raising to a Negative Exponent 6^{-3} $\frac{1}{6^{-3}}$	Write the expression as a fraction, move the expression to the denominator and change to a positive exponent .	$\frac{6^{-3}}{1} = \frac{1}{6^3}$
	Move the expression to the numerator and change to a positive exponent .	$\frac{1}{6^{-3}} = \frac{6^3}{1} = 6^3$

CFU

On your whiteboards, write an exponential expression that is equivalent to 1.

Which of the following is equal to 3^{-2} ? How do you know?

- A** $\frac{3^{-2}}{1}$ **B** $\frac{1}{3^2}$ **C** $\frac{1}{3^{-2}}$

Which of the following is equal to 6^{-5} ? How do you know?

- A** $\frac{6^5}{1}$ **B** $\frac{1}{6^5}$ **C** $\frac{6^{-5}}{1}$

1. Identify exponential expressions with the same base.
2. Determine which property of exponents to apply. Hint: Look at the operation.
3. Create an equivalent expression using properties of exponents.
4. Interpret the exponential expression. "___ is equivalent to ___."

Raising to a Zero Exponent

Any base **raised** to a
zero exponent is 1.

$$7^0 = 1$$

Raising to a Negative Exponent

$$\frac{6^{-3}}{1} = \frac{1}{6^3} \quad \frac{1}{6^3} = 6^3$$

1. 9^0

2. 6^0

3. 5^{-3}

4. 3^{-2}

5. $\frac{1}{7^{-2}}$

6. $\frac{1}{4^{-3}}$

7. Match equivalent exponential expressions.

$$\frac{(4^3)^3}{4^6}$$

$$\frac{7^2}{7^{-2}}$$

$$(3^2)^2$$

$$(4^5)^2 \times 4^{-7}$$

$$3^5 \times 3^2$$

$$3^3 \times 3$$

$$4^2 \times 4^5$$

$$7^2 \times 7$$

$$\frac{7^5}{7^2}$$

$$\frac{1}{3^{-7}}$$

$$(7^2)^2$$

$$(4^2)^2 \times 4^3$$

8. Match equivalent exponential expressions.

$$\frac{6^8}{6^5}$$

$$\frac{3^3}{3^{-3}}$$

$$6^3 \times 6^2$$

$$5^6 \times 5^{-3}$$

$$(5^3)^2$$

$$6^5 \times 6^{-2}$$

$$(3^3)^2$$

$$(5^2)^3$$

$$\frac{5^5 \times 5^5}{5^7}$$

$$\frac{(6^5)^2}{6^5}$$

$$(3^3)^2 \times 3^{-1}$$

$$3^3 \times 3^2$$

Skill Closure

1. Identify exponential expressions with the same base.
2. Determine which property of exponents to apply. Hint: Look at the operation.
3. Create an equivalent expression using properties of exponents.
4. Interpret the exponential expression. "____ is equivalent to ____."

Multiplying

Keep the base,
add the exponents

$$3^2 \times 3^5 = 3^{2+5}$$

Dividing

Keep the base,
subtract the exponents

$$\frac{4^6}{4^3} = 4^{6-3}$$

Raising to an Exponent

Keep the base,
multiply the exponents

$$(5^4)^3 = 5^{4 \times 3}$$

Raising to a Zero Exponent

Any base raised to a
zero exponent is 1.

$$7^0 = 1$$

Raising to a Negative Exponent

$$\frac{6^{-3}}{1} = \frac{1}{6^3} \quad \frac{1}{6^3} = 6^{-3}$$

1. $4^3 \times 4^2$

2. $(4^3)^2$

3. 4^{-3}

Concept Closure

Caroline made a mistake applying the properties of exponents.
Explain the error she made.

$$\frac{4^8}{2^5} = 2^{8-5} = 2^3$$

Closure

What did you learn today about applying properties of exponents?

Word Bank

exponents
properties
raising
zero
negative

1. Identify exponential expressions with the same base.
2. Determine which property of exponents to apply. Hint: Look at the operation.
3. Create an equivalent expression using properties of exponents.
4. Interpret the exponential expression. "___ is equivalent to ___."

Multiplying

Keep the base,
add the exponents

$$3^2 \times 3^5 = 3^{2+5}$$

Dividing

Keep the base,
subtract the exponents

$$\frac{4^6}{4^3} = 4^{6-3}$$

Raising to an Exponent

Keep the base,
multiply the exponents

$$(5^4)^3 = 5^{4 \times 3}$$

Raising to a Zero Exponent

Any base raised to a
zero exponent is 1.

$$7^0 = 1$$

Raising to a Negative Exponent

$$\frac{6^{-3}}{1} = \frac{1}{6^3} \quad \frac{1}{6^3} = 6^3$$

1. $5^2 \times 5^2$

2. $\frac{3^5}{3^2}$

3. $\frac{2^2 \times 2^2}{5^2}$

4. $\frac{4^2 \times 6^9}{6^7}$

5. $(2^2)^4$

6. $(2^2)^3 \times 2$

7. $\frac{(7^3)^3}{7^6}$

8. 11^0

9. 8^{-2}

10. $\frac{1}{9^{-3}}$

Multiplying

Keep the base,
add the exponents

$$3^2 \times 3^5 = 3^{2+5}$$

Dividing

Keep the base,
subtract the exponents

$$\frac{4^6}{4^3} = 4^{6-3}$$

Raising to an Exponent

Keep the base,
multiply the exponents

$$(5^4)^3 = 5^{4 \times 3}$$

Raising to a Zero Exponent

Any base raised to a
zero exponent is 1.

$$7^0 = 1$$

Raising to a Negative Exponent

$$\frac{6^{-3}}{1} = \frac{1}{6^3} \quad \frac{1}{6^3} = 6^3$$

Create an equivalent expression using properties of exponents.

1. $\frac{(9^4)^3}{9^{12}}$

2. $\frac{6^5 \times 6^4}{6^{11}}$

3. $(2^3)^2 \times 5^2$

4. $\frac{4^5}{4^6}$

5. $(5^2)^2 \times 6^0$

6. $(3^2)^{-2}$

For each exponential expression, mark whether it is greater than or less than 3^4 .

1. $3^2 \times 3$

2. $\frac{(3^5)^2}{3^{10}}$

3. $\frac{3^3}{3^{-4}}$

4. $(4^2)^2$

5. $\frac{3^2 \times 3^5}{3^{12}}$

6. $\frac{1}{3^{-6}}$

Greater than 3^4	Less than 3^4

MultiplyingKeep the base,
add the exponents

$$3^2 \times 3^5 = 3^{2+5}$$

DividingKeep the base,
subtract the exponents

$$\frac{4^6}{4^3} = 4^{6-3}$$

Raising to an ExponentKeep the base,
multiply the exponents

$$(5^4)^3 = 5^{4 \times 3}$$

Raising to a Zero ExponentAny base raised to a
zero exponent is 1.

$$7^0 = 1$$

Raising to a Negative Exponent

$$\frac{6^{-3}}{1} = \frac{1}{6^3} \quad \frac{1}{6^3} = 6^{-3}$$

Create an equivalent expression using properties of exponents.

1. $\frac{1}{8^{-3}}$

2. $\frac{5^3}{7^0}$

3. $(9^3)^0 \times 2^3$

4. $\frac{4^2}{4^{-1}}$

5. Correct the error made in applying the properties of exponents.
Then describe the error made.

1a. $6^4 \times 6^5 = 6^4 \times 5 = 6^{20}$

1b. $7^3 \times 7^2 = 7^3 \times 2 = 7^6$

1c. $2^5 \times 2^3 = 2^5 \times 3 = 2^{15}$

6. Correct the error made in applying the properties of exponents.
Then describe the error made.

2a. $3^2 \times 2^3 = 6^{2+3} = 6^5$

2b. $5^2 \times 5^2 = 25^{2+2} = 25^4$

2c. $4^3 \times 3^1 = 12^{3+1} = 12^4$

7. Correct the error made in applying the properties of exponents.
Then describe the error made.

3a. $\frac{10^6}{5^3} = 2^{6-3} = 2^3$

3b. $\frac{9^8}{3^6} = 3^{8-6} = 3^2$

3c. $\frac{12^9}{3^5} = 4^{9-5} = 4^4$

8. Correct the error made in applying the properties of exponents.
Then describe the error made.

4a. $\frac{7^6}{7^3} = 7^{6 \div 3} = 7^2$

4b. $\frac{5^{10}}{5^2} = 5^{10 \div 2} = 5^5$

4c. $\frac{3^8}{3^2} = 3^{8 \div 2} = 3^4$

MultiplyingKeep the base,
add the exponents

$$3^2 \times 3^5 = 3^{2+5}$$

DividingKeep the base,
subtract the exponents

$$\frac{4^6}{4^3} = 4^{6-3}$$

Raising to an ExponentKeep the base,
multiply the exponents

$$(5^4)^3 = 5^{4 \times 3}$$

Raising to a Zero ExponentAny base raised to a
zero exponent is 1.

$$7^0 = 1$$

Raising to a Negative Exponent

$$\frac{6^{-3}}{1} = \frac{1}{6^3} \quad \frac{1}{6^3} = 6^3$$

Create an equivalent expression using properties of exponents.

1.

$$\frac{(7^5)^3}{7^{17}}$$

2.

$$\frac{10^5 \times 10^6}{10^7}$$

1. Choose Yes or No to indicate whether each expression is equivalent to $5^3 \times 5^{-4}$.

A $\frac{5^3}{5^4}$

☐ Yes ☐ No

B 5^{-12}

☐ Yes ☐ No

C $\frac{1}{5}$

☐ Yes ☐ No

D $5^3 + (-4)$

☐ Yes ☐ No2. Choose Yes or No to indicate whether each expression is equivalent to $\frac{3^8}{3^5}$.

A $3^8 \times 3^{-5}$

☐ Yes ☐ No

B 3^3

☐ Yes ☐ No

C $\frac{1}{27}$

☐ Yes ☐ No

D $3^8 + (-5)$

☐ Yes ☐ No3. Choose Yes or No to indicate whether each expression is equivalent to $(4^2)^{-1}$.

A $\frac{1}{4^2}$

☐ Yes ☐ No

B 4^{-2}

☐ Yes ☐ No

C $4^4 \times 4^{-6}$

☐ Yes ☐ No

D 16

☐ Yes ☐ No