

Exponents

Day 1 laws of Exponents

Multiplication of powers

$$X^m \cdot X^n = X^{m+n}$$

Examples:

Division of powers

$$\frac{X^m}{X^n} = X^{m-n}$$

Examples:

Jul 7-10:02 AM

Power of a power law

$$(X^m)^n = X^{mn}$$

Examples:

Root of a power law

$$\sqrt[n]{X^m} = X^{\frac{m}{n}}$$

Examples:

$$\sqrt{X^6} = X^{\frac{6}{2}} \quad \sqrt[3]{2^{12}} = 2^{\frac{12}{3}} = 2^4 \quad \sqrt[4]{5^{20}} = 5^{\frac{20}{4}} = 5^5$$

Jul 7-10:05 AM

Power of a product law

$$(xy)^n = x^n y^n$$

Examples:

Power of a Quotient Law

$$\left(\frac{x}{y}\right)^n = \frac{x^n}{y^n}$$

Examples:

Jul 7-10:07 AM

Look at the problem
at the right.



$$\frac{y^3}{y^2}$$

If we subtract the exponents, we get:

$$\frac{y^3}{y^2} = y^{3-2} = y^1$$

If we "cancel" like terms, we get:

$$\frac{y^3}{y^2} = \frac{\cancel{y} \cancel{y} y}{\cancel{y} \cancel{y}} = y^1$$

Obviously, these answers are the same !!!!!

What if the problem were
upside down?



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

If we subtract the exponents, we get:

$$\frac{1^2}{1^3} = 1^{2-3} = 1^{-1}$$

If we cancel, we get:

$$\frac{\cancel{1} \cancel{1}}{\cancel{1} \cancel{1} 1} = \frac{1}{1}$$

While not obvious, these answers are indeed *EQUAL* answers !!!!!

Jul 7-10:09 AM

Try these

1) $(16^3)^{\frac{1}{2}}$

2) $\sqrt[4]{16y^{16}}$

3) $(4x)^{\frac{1}{2}}$

4) Simplify: $\left(\frac{x^{\frac{1}{2}}}{x^{-\frac{1}{2}}}\right)$

5) Simplify: $(4x^4y^8)^{\frac{1}{2}}$

Jul 7-10:11 AM

Name _____

Day 1

Date _____

Laws of exponents

Multiplication of powers

$$X^m \bullet X^n = X^{m+n}$$

Examples:

$$X^3 \bullet X^2 = X^5$$

$$10^3 \bullet 10^5 = 10^8$$

$$2^x \bullet 2^y = 2^{x+y}$$

Division of powers

$$\frac{X^m}{X^n} = X^{m-n}$$

Examples:

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

$$\frac{3^9}{3^5} = 3^4$$

Power of a power law

$$(X^m)^n = X^{mn}$$

Examples:

$$(X^5)^3 = X^{15}$$

$$[(X^2)^3]^4 = X^{24}$$

$$(5^a)^b = 5^{ab}$$

Root of a power law

$$\sqrt[n]{X^m} = X^{\frac{m}{n}}$$

Examples:

$$\sqrt[6]{X^6} = X^{\frac{6}{2}} = X^3$$

$$\sqrt[3]{2^{12}} = 2^{\frac{12}{3}} = 2^4$$

$$\sqrt[4]{5^{4a}} = 5^{\frac{4a}{4}} = 5^a$$

Power of a product law

$$(xy)^m = x^m y^m$$

Examples:

$$(x^2 y^3)^2 = (x^2)^2 (y^3)^2 = x^4 y^6$$

$$(2x^2)^5 = (2)^5 (x^2)^5 = 2^5 x^{10} = 32x^{10}$$

Power of a Quotient Law

$$\left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}$$

Examples:

$$\left(\frac{a}{b}\right)^7 = \frac{a^7}{b^7}$$

$$\left(\frac{x^2}{y^3}\right)^2 = \frac{(x^2)^2}{(y^3)^2} = \frac{x^4}{y^6}$$

1) $x^5 \bullet x^7$

2) $a^{2b} \bullet a^{4b}$

3) $y^{2n} \bullet y^5$

4) $b^3 \bullet b^{2a-1}$

5) $y^8 \div y^4$

6) $A^5 \div A^2$

7) $b^{3n} \div b^n$

8) $w^{3n+4} \div w^{n+1}$

9) $(c^2)^5$

10) $(c^2 d^3)^5$

11) $(2r^3 c^4)^5$

12) $(c^t d^r)^s$

13) $\left(\frac{a}{b}\right)^c$

14) $\left(\frac{r^2 s^3}{t^3}\right)^a$

15) $\left(\frac{2x^2}{3y^3}\right)^3$

16) $\left(\frac{2a^5 x^2}{3b^2 y^4}\right)^3$

17) $\sqrt{x^8}$

18) $\sqrt[3]{y^9}$

19) $\sqrt[4]{r^4}$

20) $\sqrt[3]{a^3 b^6}$

DAY 2

Power of zero:

$$\frac{X^m}{X^m} = X^{m-m} = X^0 = 1$$

Example:

$$\frac{X^3}{X^3} = \boxed{}$$

Negative Exponent:

$$X^{-n} = \frac{1}{X^n}$$

Example:

$$\frac{X^3}{X^3} = \boxed{}$$

Jul 7-10:07 AM

Write each expression as a positive exponent:

1) x^{-5}

2) x^{-1}

3) $(x^{-4})^2$

4) $x^{-5} \cdot x^3$

5) $\frac{1}{x^{-4}}$

6) $3x^0$

Sep 23-8:31 AM

Transform each given expression into an equivalent one with positive exponents.

1) 4^{-3}

2) 10^{-1}

3) $\frac{1}{2^{-5}}$

4) $\left(\frac{5}{3}\right)^{-2}$

5) $2^7 \cdot 2^{-3}$

6) $(x^4)^{-3}$

7) $(y^{-2})^{-4}$

8) $(3x)^0$

Sep 23-8:46 AM

Name _____

Date _____

Day 2

Power of zero:

$$\frac{X^m}{X^m} = X^{m-m} = X^0 = 1$$

Example:

$$\frac{X^5}{X^5} = X^0 = 1$$

Negative Exponent:

$$X^{-n} = \frac{1}{X^n}$$

Example:

$$\frac{X^5}{X^9} = X^{-4} = \frac{1}{X^4}$$

Problems:

Use a radical sign to indicate the expression.

1) $5^{\frac{1}{2}}$

2) $7^{\frac{1}{3}}$

3) $c^{\frac{1}{3}}$

4) $(2b)^{\frac{1}{2}}$

Use fractional exponents to express the radical:

1) $\sqrt{7}$

2) $\sqrt[3]{8}$

3) $\sqrt[3]{x}$

4) $\sqrt[3]{a^4}$

5) $\sqrt[4]{x^2 y^3}$

6) $\sqrt[5]{r^2 s^3}$

Transform the expression into equivalent expressions involving positive exponents.

1) y^{-5}

2) $3a^{-4}$

3) $a^{-2}b^3$

4) $5c^{-1}b^2$

5) $(8r)^{-2}$

6) $(3s)^{-4}$

Transform the expression into equivalent expressions involving positive exponents.

1) $\frac{1}{a^{-3}}$

2) $\frac{5}{x^{-1}}$

3) $\frac{3}{y^{-5}}$

4) $\frac{r^{-2}}{t^{-3}}$

5) $\frac{m^2}{n^{-3}}$

6) $\frac{a^{-4}b}{cd^{-3}}$

7) $\frac{5x^{-4}}{7y^3}$

Transform the fraction into an equivalent expression WITHOUT a denominator:

1) $\frac{x^2}{y^3}$

2) $\frac{5ab^3}{c^4}$

3) $\frac{c^2}{d^{-1}}$

4) $\frac{8rs^2}{mn^3}$

Name: _____

Day 3 classwork

1) The expression $(a^2)^3$ is equivalent to

- A) a^6 C) a^5
 B) $3a^2$ D) $2a^5$

2) The expression $(-3x^2y^3)^3$ is equivalent to

- A) $-27x^6y^9$ C) $-27x^5y^6$
 B) $-9x^6y^9$ D) $-3x^5y^6$

3) The expression $\frac{x^4}{x^3}$ is equivalent to

- A) $7x$ C) x
 B) x^7 D) $x^{\frac{4}{3}}$

4) Evaluate: $\frac{2^{-3} + 3^{-2}}{8^{-1}}$

- A) $\frac{17}{8}$ C) $\frac{8}{17}$
 B) $\frac{17}{9}$ D) $\frac{10}{9}$

5) Evaluate: $\frac{3^{-2} + 2^{-3}}{9^{-1}}$

- A) $\frac{9}{8}$ C) $\frac{8}{17}$
 B) $\frac{17}{8}$ D) $\frac{8}{9}$

6) Simplify: $\frac{3^{x+4}}{3^x}$

- A) -81 C) 81
 B) $\frac{1}{81}$ D) $-\frac{1}{81}$

7) Simplify: $(3a^2)^3$ 8) Simplify: $\frac{4x^7}{2x^3}$ 9) Simplify: $(a^2b^2c)^3$ 10) Simplify: $\sqrt[3]{a^{12}}$ 11) Simplify: $\sqrt{a^4 \cdot b^8}$ 12) Simplify: $\sqrt[3]{-8x^6y^3}$ 13) Simplify and express with positive exponents: $4x^{-2}$ 14) Simplify and express with positive exponents: $-8y^{-3}$ 15) Simplify and express with positive exponents: $a^2 \cdot a^{-6}$ 16) Simplify and express with positive exponents: $y^{-6} \cdot y^8$ 17) Simplify and express with positive exponents: $\frac{3}{4x^{-3}}$ 18) Simplify and express with positive exponents: $\frac{6a^{-3}b^2}{3ab^{-2}}$

- 19) Simplify and express with positive exponents: $\frac{4y^{-3}}{2y^{-4}}$
- 20) Simplify and express with positive exponents: $\frac{-3x^{-4}}{6x^{-1}}$
- 21) Simplify and express with positive exponents: $(-3x)^{-2}$
- 22) Simplify and express with positive exponents: $(d^{-4})^{-3}$
- 23) Simplify: 6^0
- 24) Simplify: $3 + 5^0$
- 25) Simplify: $2^0 \cdot x$
- 26) Simplify: -3^{-3}
- 27) Simplify: $81 \cdot 3^{-2}$
- 28) The value of $(-64)^{\frac{2}{3}}$ is
- A) 512 C) $-\frac{1}{16}$
B) 16 D) -16
- 29) $8^{\frac{2}{3}}$ is equivalent to
- A) $\sqrt[3]{16}$ C) $4^{\frac{4}{3}}$
B) $\sqrt[3]{8^2}$ D) $\sqrt{8^3}$
- 30) Express with rational exponents: $\sqrt{3}$
- 31) Express with rational exponents: $\sqrt{3x}$
- 32) Express with rational exponents: $\sqrt[3]{y^4}$
- 33) Express with rational exponents: $\sqrt[3]{x^2y^4}$
- 34) Express in radical form: $(3a)^{\frac{1}{2}}$
- 35) Simplify: $4^0 - 8^{\frac{2}{3}} + 9^{\frac{1}{2}}$



Day 4

Exponential Equations (Unknown Base)

1) $5x^{1/2} + 2 = 52$

Rules for Solving:

- 1) Isolate the x-value
- 2) Raise both sides to the reciprocal of the exponent.
- 3) Solve for x
- 4) Check

Jul 7-10:18 AM

2) $x^{3/4} = 8$

Rules for Solving:

- 1) Isolate the x-value
- 2) Raise both sides to the reciprocal of the exponent.
- 3) Solve for x
- 4) Check

3) $3x^{3/2} = 192$

4) $-4s^{-3/5} - 1 = 31$

Jul 7-10:23 AM

Name _____

Date _____

Exponents Day 4

Example:

$$2X^{-\frac{1}{3}} = 6$$

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

$$\left(X^{-\frac{1}{3}}\right)^{-3} = 3^{-3}$$

$$X = 3^{-3}$$

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

$$X = \frac{1}{27}$$

Example:

$$X^{\frac{3}{2}} + 1 = 9$$

$$X^{\frac{3}{2}} = 8$$

$$\left(X^{\frac{3}{2}}\right)^{\frac{2}{3}} = (8)^{\frac{2}{3}}$$

$$X = 8^{\frac{2}{3}}$$

$$X = \sqrt[3]{8^2}$$

$$X = 4$$

SOLVE AND CHECK:

1) $X^{\frac{1}{2}} = 7$

2) $X^{\frac{1}{3}} = 5$

3) $X^{\frac{2}{3}} = 4$

4) $X^{-2} = 9$

5) $X^{-\frac{1}{4}} = 2$

6) $X^{-\frac{1}{2}} = \frac{1}{3}$

7) $X^{\frac{4}{3}} - 1 = 15$

8) $X^{-\frac{3}{2}} + 2 = 10$

9) $2X^{\frac{4}{3}} = 162$

10) $2X^{-\frac{1}{2}} = 3$

11) $2X^{-\frac{1}{4}} + 3 = 4$

12) $4X^{\frac{2}{3}} - 5 = 20$

Name: _____
Day 5

1) What value(s) of x would satisfy the equation $2x^{\frac{2}{5}} = 32$?

2) Solve: $x^{\frac{2}{3}} = 64$

3) Solve: $x^{\frac{2}{3}} = 16$

4) Solve: $x^{\frac{3}{2}} = 64$

5) Solve: $x^{\frac{3}{4}} = 27$

6) Find the value of x that satisfies the equation $x^{\frac{3}{2}} = 64$.

7) Solve: $x^{-2} = 25$

8) Solve: $c^{-3} = 8$

9) Solve: $x^{\frac{1}{2}} = 4$

10) Solve: $y^{\frac{1}{3}} = 2$

11) Solve: $2y^{\frac{1}{2}} = 6$

12) Solve: $3y^{\frac{1}{3}} - 2 = 4$

13) Solve: $4x^{\frac{1}{5}} + 2 = 10$

14) Solve: $y^{-\frac{1}{3}} - 1 = 2$

15) Solve: $2x^{-\frac{1}{2}} - 4 = 2$

16) Solve: $b^{\frac{3}{2}} = 8$

17) Solve: $y^{-\frac{2}{3}} = \frac{4}{9}$



Day 6

Exponential Equations (Common Base)

1) $2^{3y-6} = 8$

Rules for Solving:

- 1) Find a common base
- 2) Set the exponents equal to each other
- 3) Solve for x
- 4) Check



If you can express both sides of the equation as powers of the same base, you can set the exponents equal to solve for x.

Jul 7-10:18 AM

2) $9^x = 27$

3) $4^{x+1} = 8^x$

4) $(1/9)^x = 27^{1-x}$

Rules for Solving:

- 1) Find a common base
- 2) Set the exponents equal to each other
- 3) Solve for x
- 4) Check

Jul 7-10:23 AM

Name _____ Day 6 Date _____

Class work/ Homework

Solving problems involving exponential equations

Solve for t: $27^{6-t} = 9^{t-1}$

$$(3^3)^{6-t} = (3^2)^{t-1}$$

$$3^{18-3t} = 3^{2t-2}$$

Since both sides now have the same base, the exponents are equal

$$18-3t=2t-2$$

$$20=5t$$

$$t=4$$

Solve and check:

1) $2^{X+1} = 8$

2) $2^X = 8^{X+1}$

3) $3^{2X-1} = 27$

4) $2^{X+3} = 64$

5) $4^{3X} = 2^{X+5}$

6) $8^{\frac{1}{3}} = 2^{X+1}$

7) $4^{2X} = 2^{3X+2}$

8) $5^{3X-2} = 25$

9) $9^X = 27$

10) $4^{X+2} = 8$

11) $16^{X+2} = 8^{-X}$

12) $16^{3X} = 8^{X+1}$

13) $27^X = 9^{X+2}$

14) $4^{3X} = 8^{X+1}$

15) $16^{X-\frac{3}{4}} = 4^{3X-5}$

Name _____ Day 7
Class work/ Homework

Date _____

1) $4^{x-2} = 4^{3x}$

2) $2^x = 4$

3) $5^{x-1} = 125$

4) $49^x = 7^{x+1}$

5) $36^x = 6^{x-1}$

6) $64^x = 4^{x+2}$

7) $9^{2x} = 3^{3x+1}$

8) $8^x = 4^{x-1}$

9) $27^x = 9^{x+2}$

10) $4^{x+1} = \frac{1}{64}$

11) $\left(\frac{1}{3}\right)^{1-x} = 9^x$

14) $\left(\frac{1}{4}\right)^x = 8^{1-x}$

15) $\left(\frac{1}{2}\right)^x = 8^{2-x}$

16) $8^{x-2} = \sqrt{8}$

Name: _____

Day 8 Test Review

1) If $y = \frac{1}{3}$, find the value of $y^{-1} - 3y^0$.

A) $-\frac{2}{3}$

C) 0

B) 1

D) $\frac{2}{3}$

2) Simplify: $\frac{3x+4}{3x}$

A) -81

C) 81

B) $\frac{1}{81}$

D) $-\frac{1}{81}$

3) Simplify: $\frac{9x^3}{27x^6}$

4) Simplify: $\left(\frac{x}{y}\right)^a$

5) Simplify: $\sqrt{x^6}$

6) Simplify: $\sqrt[3]{a^{12}}$

7) Simplify and express with positive exponents:
 $4x^{-2}$

8) Simplify and express with positive exponents:
 $(-3x)^{-2}$

9) Simplify: $3x^0$

10) Simplify: $(x^{-2})^3$

11) $4^{\frac{3}{2}}$ is equivalent to

A) $\sqrt[3]{64}$

C) $(\sqrt{64})^3$

B) $\sqrt{64}$

D) $\sqrt[3]{16}$

12) Express with rational exponents: $\sqrt{3}$

13) Express with rational exponents: $\sqrt{3x}$

14) Express with rational exponents: $\sqrt[3]{x^2y^4}$

15) Express in radical form: $(-3x)^{\frac{1}{3}}$

16) Simplify: $(81)^{\frac{1}{4}}$

17) The solution set of $2^{x+1} = 8$ is

- | | |
|------------|------------|
| A) $\{ \}$ | C) $\{2\}$ |
| B) $\{4\}$ | D) $\{3\}$ |

18) Solve: $16^{x-1} = 8^x$

- | | |
|----------------------|----------------------|
| A) $x = -1$ | C) $x = 4$ |
| B) $x = \frac{4}{3}$ | D) $x = \frac{1}{4}$ |

19) If $3^x = \frac{1}{9}$, what is the value of x ?

20) Find the value of x that satisfies the equation
 $x^{\frac{3}{2}} = 64$.

21) Solve: $c^{-3} = 8$

22) Solve: $x^{\frac{1}{4}} = 3$

23) Solve: $3y^{\frac{1}{3}} - 2 = 4$

24) Solve: $y^{-\frac{1}{3}} - 1 = 2$

25) Solve for x : $9^x = 27$.