EXPONENT RULES

1. Multiplication Rule:
$(a^m)(a^n) = a^{m+n}$
e.g. $(-x^2)(2x^3) = -2x^{2+3} = -2x^5$

2. Power of a Product Rule:
$(ab)^m = a^m b^m$
e.g. $(-3xy)^3 = (-3)^3(x)^3(y)^3 = -27x^3y^3$

3. Power of a Power Rule:
$(a^m)^n = a^{mn}$
e.g. $(2x^2y^3)^3 = (2)^3(x^{2\cdot3})(y^{3\cdot3}) = 8x^6y^9$

4. Division Rule:
$\frac{(a^m)}{(a^n)} = a^{m-n}$
e.g. $\frac{x^4}{x^2} = x^{4-2} = x^2$

5. Quotient Rule:
$(\frac{a}{b})^m = \frac{a^m}{b^m}$
e.g. $(\frac{x^3}{y^4})^2 = \frac{x^{3\cdot2}}{y^{4\cdot2}} = \frac{x^6}{y^8}$

6. Zero Exponent
A power with an exponent of zero is equal to . . .
$b^0 = 1$ e.g. $9^0 = 1$

7. Negative Exponent
When you are evaluating a power with a negative exponent, you . . .
Case 1. $b^{-x} = \frac{1}{b^x}$
e.g. $3^{-1} = 1/3$ e.g. $3^{-2} = \frac{1}{3^2} = 1/9$

Case 2. $(\frac{a}{b})^{-1} = (\frac{b}{a})^1 = \frac{b}{a}$
e.g. $(\frac{4}{3})^{-1} = (\frac{3}{4})^1 = 3/4$
e.g. $(\frac{4}{3})^{-2} = (\frac{3}{4})^2 = \frac{3^2}{4^2} = 9/16$

Practice:

1. $(3m^2n)(4mn^3) = 12m^{2+1}n^{1+3} = 12m^3n^4$

2. $\frac{24k^5q^3}{2k^2q} = 12k^{5-2}q^{3-1} = 12k^3q^2$

3. $(2a^3b^2)^3 = (2)^3(a^{3\cdot3})(b^{2\cdot3}) = 8a^9b^6$

4. $\frac{(2x^2y^3)(3x^3y^2)^2}{(4x^5y^5)} = \frac{(2x^2y^3)(3)^2(x^{3\cdot2})(y^{2\cdot2})}{4x^5y^5}$
$= \frac{2x^2y^3(9x^6y^4)}{4x^5y^5}$
$= \frac{18x^{2+6}\cdot y^{3+4}}{4x^5y^5}$
$= \frac{18x^8y^7}{4x^5y^5}$
$= \frac{9x^{8-5}y^{7-5}}{2}$
$= \frac{9x^3y^2}{2}$

5. $(\frac{x^4y}{x^2y^2})^3 = \frac{x^{4\cdot3}\cdot y^{1\cdot3}}{x^{2\cdot3}\cdot y^{2\cdot3}}$
$= \frac{x^{12}y^3}{x^6\cdot y^6}$
$= \frac{x^{12-6}}{y^{6-3}}$ or $x^{12-6}y^{3-6}$
$= \frac{x^6}{y^3}$ or x^6y^{-3}

Task 1: Graphing the Exponential Relation

For each equation:

a. Fill in the table of values.

b. Draw the graph and determine the key features of each graph as indicated below the grids.

c. Check your graphs using DESMOS.

$y = x^2$

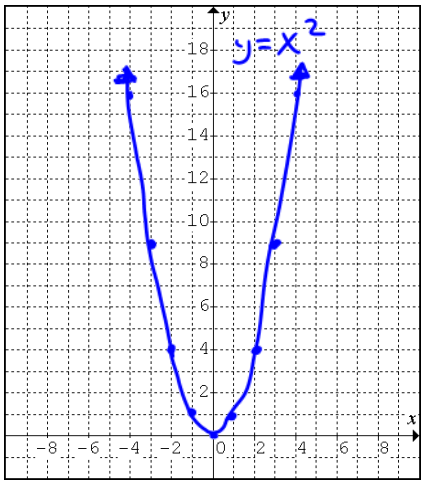
x	y
-3	$(-3)^2 = 9$
-2	$(-2)^2 = 4$
-1	$(-1)^2 = 1$
0	$(0)^2 = 0$
1	$(1)^2 = 1$
2	$(2)^2 = 4$
3	$(3)^2 = 9$

$y = 2^x$

x	y
-3	$2^{-3} = 1/8 = 0.125$
-2	$2^{-2} = 1/4 = 0.25$
-1	$2^{-1} = 1/2 = 0.5$
0	$2^0 = 1$
1	$2^1 = 2$
2	$2^2 = 4$
3	$2^3 = 8$

$y = \left(\frac{1}{2}\right)^x$

x	y
-3	$\left(\frac{1}{2}\right)^{-3} = 2^3 = 8$
-2	$\left(\frac{1}{2}\right)^{-2} = 2^2 = 4$
-1	$\left(\frac{1}{2}\right)^{-1} = 2^1 = 2$
0	$\left(\frac{1}{2}\right)^0 = 1$
1	$\left(\frac{1}{2}\right)^1 = 0.5$
2	$\left(\frac{1}{2}\right)^2 = 1/4 = 0.25$
3	$\left(\frac{1}{2}\right)^3 = 1/8 = 0.125$

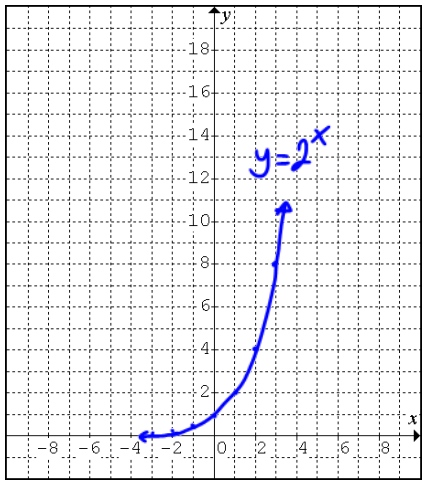


y-intercept = (0,0)

x-intercept = (0,0)

vertex = (0,0)

axis of symmetry: x=0

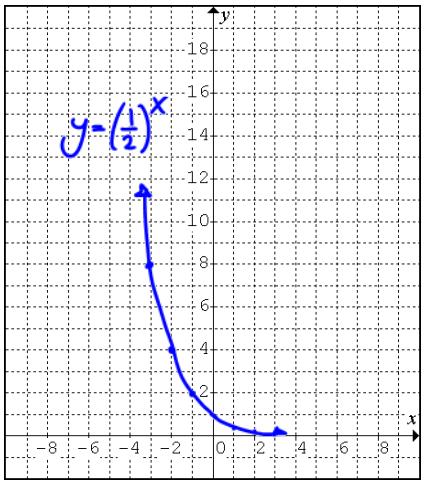


y-intercept = (0,1)

x-intercept = none

increasing or decreasing?

increasing as the x values increase



y-intercept = (0,1)

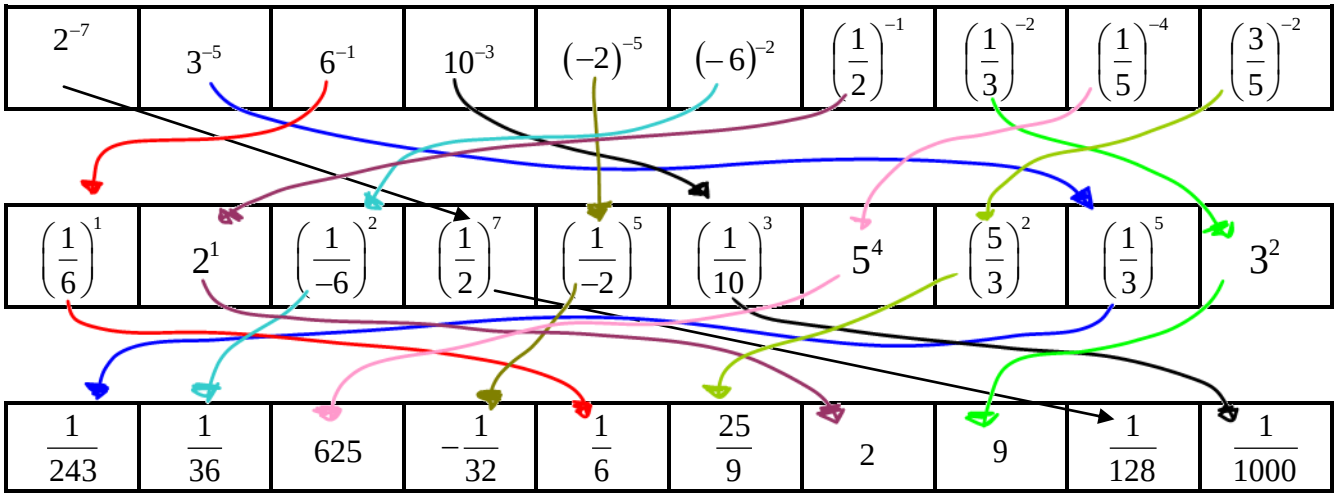
x-intercept = none

increasing or decreasing?

decreasing as the x values increase.

Practice

17. Match the power in the first row with the equivalent power in the second row, and the answer in the third row. Join them all with a line. The first one has been done for you.



18. Walker states that $8^{-4} = \left(\frac{1}{8}\right)^{4}$. Paige states that $8^{-4} = \frac{1}{8^4}$. They are both correct. Explain why.

1. Please evaluate. DO NOT use decimals. Your answer should be an integer or a fraction.

a. $3^{-4} = \frac{1}{3^4} = \frac{1}{81}$ b. $8^{-3} = \frac{1}{8^3} = \frac{1}{512}$

c. $\frac{(-2)^{-3}}{1} = \frac{1}{(-2)^3} = \frac{1}{-8} = -\frac{1}{8}$ d. $\frac{(-4)^{-4}}{1} = \frac{1}{(-4)^4} = \frac{1}{256}$ e. $13^0 = 1$

f. $\left(\frac{1}{2}\right)^{-1} = \left(\frac{2}{1}\right)^{1} = 2$ g. $\left(\frac{1}{3}\right)^{-2} = \left(\frac{3}{1}\right)^{2} = 3^2 = 9$ h. $\left(\frac{1}{10}\right)^{-4} = \left(\frac{10}{1}\right)^{4} = \frac{10^4}{1^4} = 10{,}000$

i. $\left(\frac{2}{5}\right)^{-3} = \left(\frac{5}{2}\right)^{3}$

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

$= \frac{125}{8}$

j. $\left(\frac{4}{7}\right)^{-2} = \left(\frac{7}{4}\right)^{2}$

$= \frac{49}{16}$

k. $\left(\frac{5}{3}\right)^{-3} = \left(\frac{3}{5}\right)^{3}$

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

$= \frac{27}{125}$

2. Determine the value of the '?'.

a. $6^{?} = \frac{1}{216}$

$6^{?} = \frac{1}{6^3}$

$? = -3$

b. $?^{-4} = \frac{1}{16}$

$? = 2$

c. $7^{-2} = \frac{?}{49}$

$? = 1$

d. $3^{?} = \frac{1}{81}$

$? = -4$

e. $?^{-3} = \frac{1}{8}$

$? = 2$

f. $?^{-?} = \frac{1}{27}$

$? = 3$

3. A power has a negative exponent. The answer is $\frac{1}{16}$. What could the question have been? State THREE possibilities.

$2^{-4} = ?$

$4^{-2} = ?$

$16^{-1} = ?$