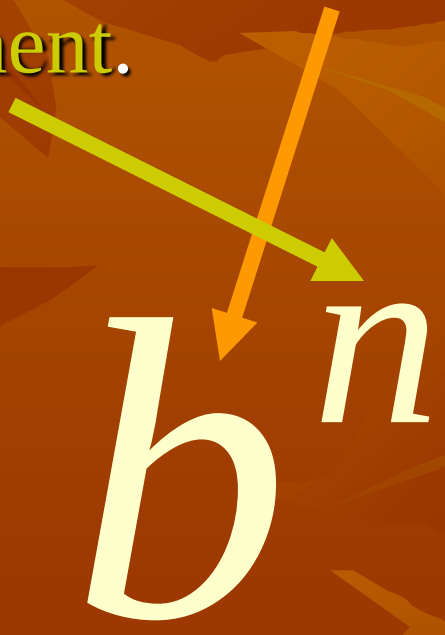
# Exponent Rules

# Parts

- When a number, variable, or expression is raised to a power, the number, variable, or expression is called the base and the power is called the exponent.



# What is an Exponent?

- An exponent means that you multiply the base by itself that many times.
- For example

$x^4 = x \cdot x \cdot x \cdot x$

$2^6 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 64$

# The Invisible Exponent

- When an expression does not have a visible exponent its exponent is understood to be 1.

$$x = x^1$$

# Exponent Rule #1

- When **multiplying** two expressions with the same base you **add** their exponents.

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

- For example

$$x^2 \cdot x^4 = x^{2+4} = x^6$$

$$2 \cdot 2^2 = 2^1 \cdot 2^2 = 2^{1+2} = 2^3 = 8$$

# Exponent Rule #1

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

- Try it on your own:

1. $h^3 \cdot h^7 = h^{3+7} = h^{10}$

2. $3^2 \cdot 3 = 3^{2+1} = 3^3$

$= 3 \cdot 3 \cdot 3 = 27$

# Exponent Rule #2

- When **dividing** two expressions with the same base you **subtract** their exponents.

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

- For example

$$\frac{x^4}{x^2} = x^{4-2} = x^2$$

# Exponent Rule #2

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

- Try it on your own:

3. $\frac{h^6}{h^2} = h^{6-2} = \boxed{h^4}$

4. $\frac{3^3}{3} = 3^{3-1} = 3^2 = \boxed{9}$

# Exponent Rule #3

- When raising a **power to a power** you **multiply** the exponents

$$(b^n)^m = b^{n \cdot m}$$

- For example

$$(x^2)^4 = x^{2 \cdot 4} = x^8$$

$$(2^2)^2 = 2^{2 \cdot 2} = 2^4 = 16$$

# Exponent Rule #3

$$(b^n)^m = b^{n \cdot m}$$

- Try it on your own

5. $(h^3)^2 = h^{3 \cdot 2} = h^6$

6. $(3^2)^2 = 3^{2 \cdot 2} = 3^4 = 81$

# Note

- When using this rule the exponent can not be brought in the parenthesis **if there is addition or subtraction**

$$(x^2 + 2^2)^2 \neq x^4 + 2^4$$

You would have to use FOIL in these cases

# Exponent Rule #4

- When a product is raised to a power, each piece is raised to the power

$$(ab)^m = a^m b^m$$

- For example

$$(xy)^2 = x^2 y^2$$

$$(2 \cdot 5)^2 = 2^2 \cdot 5^2 = 4 \cdot 25 = 100$$

# Exponent Rule #4

$$(ab)^m = a^m b^m$$

- Try it on your own

7. $(hk)^3 = h^3 k^3$

8. $(2 \cdot 3)^2 = 2^2 \cdot 3^2 = 4 \cdot 9 = 36$

# Note

- This rule is for products only. When using this rule the exponent can not be brought in the parenthesis **if there is addition or subtraction**

$$(x+2)^2 \neq x^2+2^2$$

You would have to use FOIL in these cases

# Exponent Rule #5

- When a quotient is raised to a power, both the numerator and denominator are raised to the power

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

- For example

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

# Exponent Rule #5

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

- Try it on your own

9. $\left(\frac{h}{k}\right)^2 = \frac{h^2}{k^2}$

10. $\left(\frac{4}{2}\right)^2 = \frac{4^2}{2^2} = \frac{16}{4} = 4$

# Zero Exponent

- When anything, except 0, is raised to the zero power it is 1.

$$a^0 = 1 \quad (\text{if } a \neq 0)$$

- For example

$$x^0 = 1 \quad (\text{if } x \neq 0)$$

$$25^0 = 1$$

# Zero Exponent

$$a^0 = 1 \quad (\text{if } a \neq 0)$$

- Try it on your own

11. $h^0 = 1$ (if $h \neq 0$)

12. $1000^0 = 1$

13. $0^0 =$ *undefined*

# Negative Exponents

- If $b \neq 0$, then $b^{-n} = \frac{1}{b^n}$
- For example

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

$$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$$

# Negative Exponents

- If $b \neq 0$, then $b^{-n} = \frac{1}{b^n}$
- Try it on your own:

14. $h^{-3} = \frac{1}{h^3}$

15. $2^{-3} = \frac{1}{2^3} = \frac{1}{8}$

# Negative Exponents

- The negative exponent basically flips the part with the negative exponent to the other half of the fraction.

$$\left(\frac{1}{b^{-2}}\right) = \left(\frac{b^2}{1}\right) = b^2$$

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

# Math Manners

- For a problem to be completely simplified there should not be any negative exponents

# Mixed Practice

1. $\frac{6d^5}{3d^9}$

2. $2e^4 4e^5$

3. $\left(q^4\right)^5$

4. $\left(2lp\right)^5$

5. $\frac{(x^2y)^4}{(xy)^2}$

# Mixed Practice Cont'd

6. $\dfrac{(x^3x^5)^2}{x^9}$

8. $\dfrac{(x-2y)^6}{(x-2y)^4}$

7. $(m^6n^4)^2(m^3n^2p^5)^6$

9. $\dfrac{a^6d^5}{a^4d^9}$

10. $17(840430234w^{81}x^{52}y^{-33}z^9$

# Mixed Practice Answers

1. $\frac{6d^5}{3d^9} = 2d^{5-9} = 2d^{-4} = \frac{2}{d^4}$

2. $2e^4 4e^5 = 8e^{4+5} = 8e^9$

# Mixed Practice Answers

3. $\left(q^4\right)^5 = q^{4\cdot 5} = \boxed{q^{20}}$

4. $\left(2lp\right)^5 = 2^5 l^5 p^5 = \boxed{32l^5 p^5}$

# Mixed Practice Answers

5. $\dfrac{(x^2y)^4}{(xy)^2} = \dfrac{x^8y^4}{x^2y^2} = x^{8-2}y^{4-2} = x^6y^2$

6. $\dfrac{(x^3x^5)^2}{x^9} = \dfrac{(x^8)^2}{x^9} = \dfrac{x^{16}}{x^9} = x^{16-9} = x^7$

# Mixed Practice Answers

7. $(m^6 n^4)^2 (m^3 n^2 p^5)^6$

$= m^{12} n^8 \cdot m^{18} n^{12} p^{30}$

$= m^{12+18} n^{8+12} p^{30}$

$= \boxed{m^{30} n^{20} p^{30}}$

# Mixed Practice Answers

8. $\dfrac{(x-2y)^6}{(x-2y)^4} = (x-2y)^{6-4} = (x-2y)^2$

$= (x-2y)(x-2y)$


$= x^2 - 2xy - 2xy + 4y^2$

$= x^2 - 4xy + 4y^2$

# Mixed Practice Answers

9. $\dfrac{a^6 d^5}{a^4 d^9} = a^{6-4} d^{5-9} = a^2 d^{-4}$

$$= \frac{a^2}{d^4}$$

# Mixed Practice Answers

10. $17(840430234w^{81}x^{52}y^{-33}z^{9})^{0}$

$= 17(840430234^{0} * w^{0} * x^{0} * y^{0} * z^{0})$

$= 17(1 * 1 * 1 * 1 * 1)$

$= 17(1) = \boxed{17}$