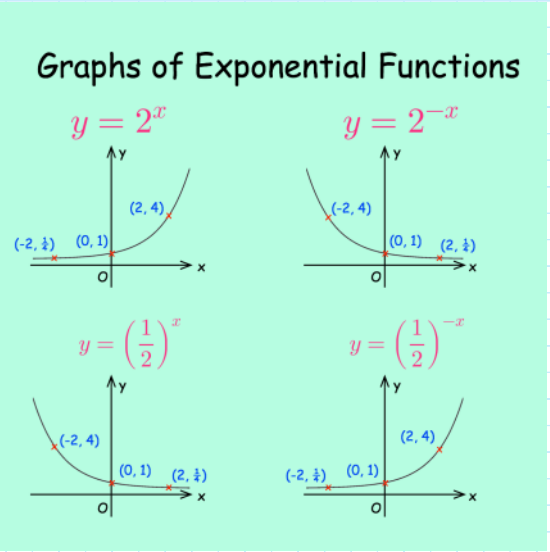
Tuesday, Feb. 20th

Plan For Today:

1. Questions from Chapter 4?
   - Hand-in Chapter 4 Project
   - Do Chapter 4 Test
2. Go over any review for Ch3 and Ch4
   - Unit 2 Exam is on Thursday
   - Rewrite will be following Tuesday after class
3. Start Chapter 5: Exponents & Logarithms
   - **5.1: Exponents**
   - 5.2: Logarithmic Functions and Graphs
   - 5.3: Properties of Logarithms
   - 5.4: Exponential and Logarithmic Equations
   - 5.5: Applications of Exponential and Log Equations
4. Work on Practice Questions from Workbook



Plan Going Forward:

1. Finish going through Chapter 3-4 practice questions and workbook reviews.

   - **UNIT 2 EXAM ON CH3&4 ON THURSDAY, FEB. 22ND**
     - 10 Multiple Choice & 20 marks on the Written
     - ~1 hour - please prepare so you are not "learning" while doing the test
     - Closed-book - no notes
     - Rewrite is following Tuesday after class at 12:30pm
     - I will email you this weekend when marks are posted so you can decide on the rewrite
     - I will go over the marked exam on Tuesday

2. We will continue in Chapter 5 after the exam on Thursday.

   - **CHAPTER 5 PROJECT DUE THURSDAY, MAR. 7TH**
   - **CHAPTER 5 TEST ON THURSDAY, MAR. 7TH**

Please let me know if you have any questions or concerns about your progress in this course. The notes from today will be posted at anurita.weebly.com after class. Anurita Dhiman = adhiman@sd35.bc.ca

Tuesday, Feb. 20th In-Class Notes

Exponent Rules

EXPONENT RULES & PRACTICE

1. PRODUCT RULE: To multiply when two bases are the same, write the base and ADD the exponents.

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

Examples:

A. $x^3 \cdot x^8 = x^{11}$ B. $2^4 \cdot 2^2 = 2^6$ C. $(x^2y)(x^3y^4) = x^5y^5$

2. QUOTIENT RULE: To divide when two bases are the same, write the base and SUBTRACT the exponents.

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

Examples:

A. $\frac{x^5}{x^2} = x^3$ B. $\frac{3^5}{3^3} = 3^2$ C. $\frac{x^2y^5}{xy^3} = xy^2$

3. ZERO EXPONENT RULE: Any base (except 0) raised to the zero power is equal to one.

$$x^0 = 1$$

Examples:

A. $y^0 = 1$ B. $6^0 = 1$ C. $(7a^3b^{-1})^0 = 1$

4. POWER RULE: To raise a power to another power, write the base and MULTIPLY the exponents.

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

Examples:

A. $(x^3)^2 = x^6$ B. $(3^2)^4 = 3^8$ C. $(z^5)^2 = z^{10}$

5. EXPANDED POWER RULE:

$$(xy)^m = x^my^n \qquad \left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}$$

$(x+y)^2 \neq x^2+y^2$
$= (x+y)(x+y)$
$x^2+2xy+y^2$

Examples:

A. $(2a)^3 = 2^3a^3 = 8a^3$

B. $(6x^3)^2 = 6^2(x^3)^2 = 36x^6$

C. $\left(\frac{x^2}{y}\right)^4 = \frac{(x^2)^4}{y^4} = \frac{x^8}{y^4}$

D. $\left(\frac{2x}{3y^2}\right)^3 = \frac{(2x)^3}{(3y^2)^3} = \frac{2^3x^3}{3^3(y^2)^3} = \frac{8x^3}{27y^6}$

6. NEGATIVE EXPONENTS: If a factor in the numerator or denominator is moved across the fraction bar, the sign of the exponent is changed.

$$x^{-m} = \frac{1}{x^m} \qquad \frac{1}{x^{-m}} = x^m \qquad \left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^n$$

Examples:

A. $x^{-3} = \frac{1}{x^3}$ B. $4^{-2} = \frac{1}{4^2} = \frac{1}{16}$ C. $-4x^5y^{-2} = \frac{-4x^5}{y^2}$

D. $\left(\frac{x^2}{y}\right)^{-3} = \left(\frac{y}{x^2}\right)^3 = \frac{y^3}{x^6}$ E. $(3x^{-2}y)(-2xy^{-3}) = -6x^{-1}y^{-2} = \frac{-6}{xy^2}$

F. $\frac{a^{-2}b^3}{c^{-4}d^{-1}} = \frac{b^3c^4d}{a^2}$ G. $(-2x^2y^{-4})^{-2} = \left(\frac{-2x^2}{y^4}\right)^{-2} = \left(\frac{y^4}{-2x^2}\right)^2 = \frac{y^8}{4x^4}$

CAUTION: $-x \neq \frac{1}{x}$ For example: $-3 \neq \frac{1}{3}$

REMEMBER: An exponent applies to <u>only</u> the factor it is directly next to *unless* parentheses enclose other factors.

Examples:

A. $(-3)^2 = (-3)(-3) = 9$ B. $-3^2 = -9$

An *exponential expression* with a fractional exponent can be expressed as a *radical* where the denominator is the index of the root, and the numerator remains as the exponent.

$a^{\frac{m}{n}}$ ⟷ $\sqrt[n]{a^m} = (\sqrt[n]{a})^m$

exponent **radical**

$a^{\frac{m}{n}}$ exponent ⟷ $\sqrt[n]{a^m} = (\sqrt[n]{a})^m$ radical

Example 1: Write $125^{\frac{1}{3}}$ as a radical expression.

$$125^{\frac{1}{3}} = \sqrt[3]{125^1} = \sqrt[3]{125} \rightarrow = 5$$

EXPONENTS PRACTICE

Simplify:

1. $3 \cdot 4^3$
2. $4x^3 \cdot 2x^3$
3. $x^5 \cdot x^3$
4. $2x^3 \cdot 2x^2$
5. $\frac{6^5}{6^3}$
6. $\frac{x^4}{x^7}$
7. 8^0
8. $-(9x)^0$
9. $(y^4)^3$
10. $(x^2y)^4$
11. $\frac{6x^7}{2x^4}$
12. $\frac{8x^5}{4x^2}$
13. $(2cd^4)^2(cd)^5$
14. $(2fg^4)^4(fg)^6$
15. $\frac{x^5y^6}{xy^2}$
16. $\frac{x^2y^5}{xy^4}$
17. $\left(\frac{4x^5y}{16xy^4}\right)^3$
18. $\left(\frac{5x^3y}{20xy^5}\right)^4$
19. y^{-7}
20. 7^{-2}
21. $\frac{1}{x^{-5}}$
22. $\frac{1}{2^{-4}}$
23. $x^5 \cdot x^{-1}$
24. x^{-6}
25. $x^9 \cdot x^{-7}$
26. $(j^{-13})(j^4)(j^6)$
27. $\frac{x^{-1}}{x^{-8}}$
28. $\frac{52x^6}{13x^{-7}}$
29. $f^{-3}(f^2)(f^{-3})$
30. $\frac{x^{-4}}{x^{-9}}$
31. $\frac{24x^6}{12x^{-8}}$
32. $\frac{3x^2y^{-3}}{12x^6y^3}$
33. $(2x^3y^{-3})^{-2}$
34. $\frac{2x^4y^{-4}}{8x^7y^3}$
35. $(4x^4y^{-4})^3$
36. $5x^2y(2x^4y^{-3})$
37. $\left(\frac{-7a^2b^3c^0}{3a^3b^4c^3}\right)^{-4}$
38. $\left(\frac{-2a^3b^2c^0}{3a^2b^3c^7}\right)^{-2}$

EXPONENTS PRACTICE ANSWERS

1. 192
2. $8x^6$
3. x^8
4. $4x^5$
5. 36
6. $\frac{1}{x^3}$
7. 1
8. -1
9. y^{12}
10. x^8y^4
11. $3x^3$
12. $2x^3$
13. $4c^7d^{13}$
14. $16f^{10}g^{22}$
15. x^4y^4
16. xy
17. $\frac{x^{12}}{64y^9}$
18. $\frac{x^8}{256y^{16}}$
19. $\frac{1}{y^7}$
20. $\frac{1}{49}$
21. x^5
22. 16
23. x^4
24. $\frac{1}{x^6}$
25. x^2
26. $\frac{1}{j^3}$
27. x^7
28. $4x^{13}$
29. $\frac{1}{f^4}$
30. x^5
31. $2x^{14}$
32. $\frac{1}{4x^4y^6}$
33. $\frac{y^6}{4x^6}$
34. $\frac{1}{4x^3y^7}$
35. $\frac{64x^{12}}{y^{12}}$
36. $\frac{10x^6}{y^2}$
37. $\frac{81a^4b^4c^{12}}{2401}$
38. $\frac{9b^2c^{14}}{4a^2}$

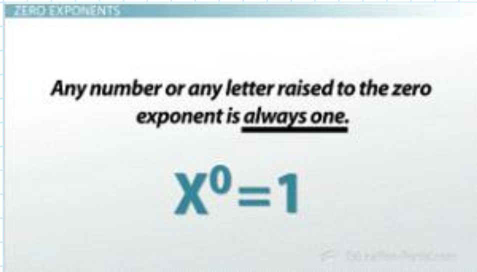
15. x y

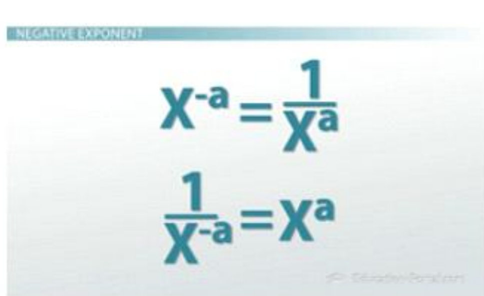
Review Exponent Rules

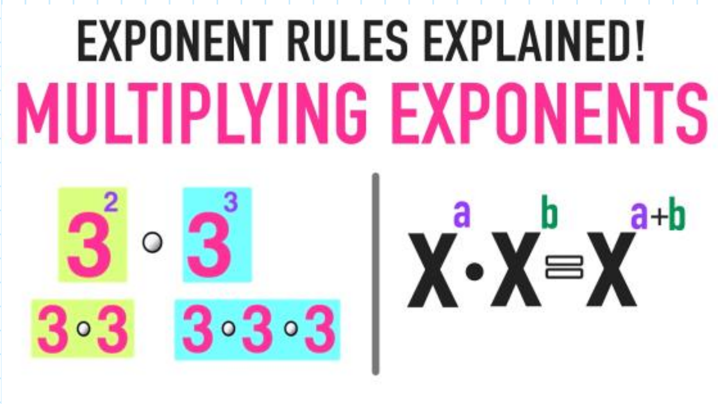
Recall some exponent rules:

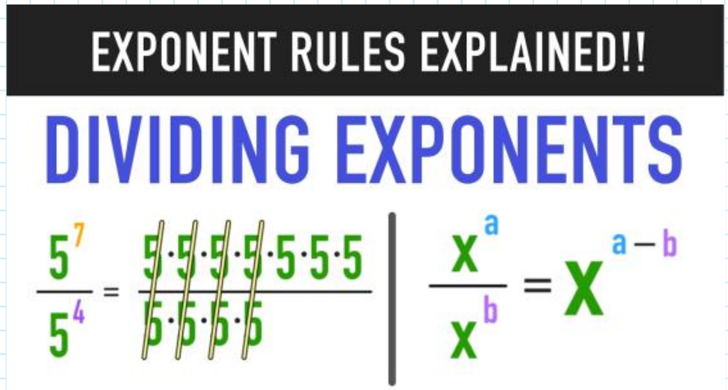
https://demonstrations.wolfram.com/LawsOfExponents/

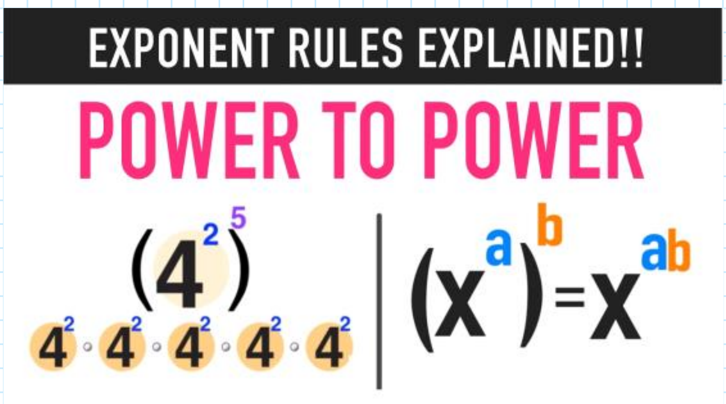
One as Exponent	Any number raised to the power of 1 is that number
$x^1 = x$	$6^1 = 6$

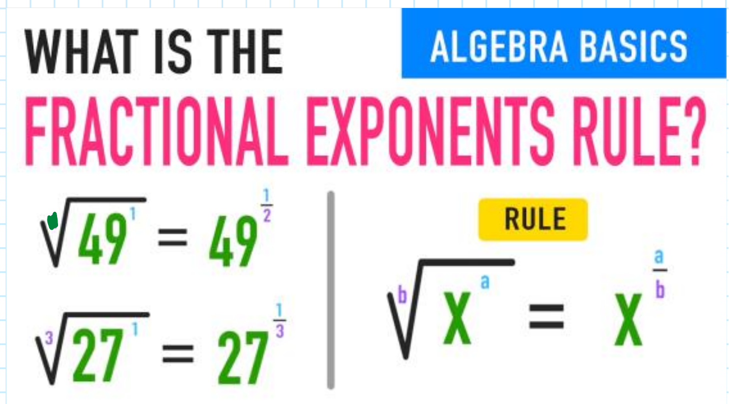


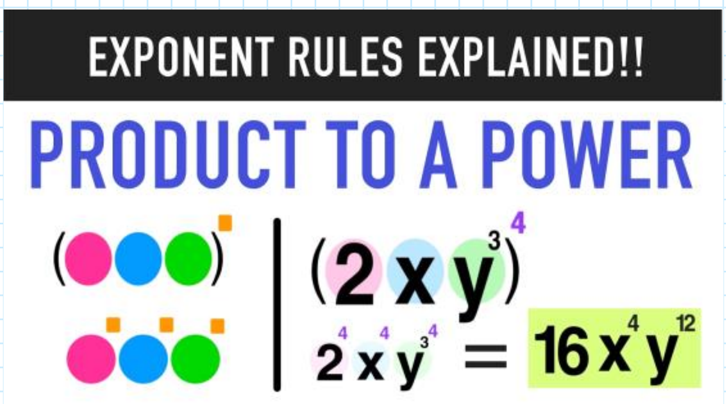


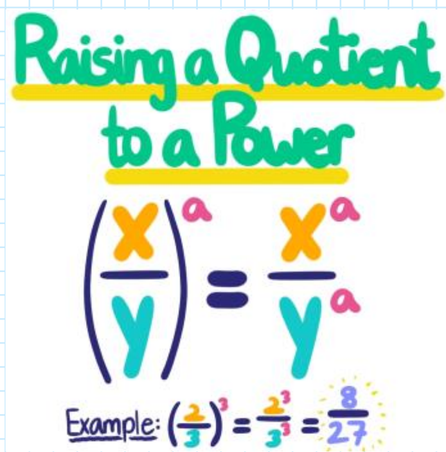












NOT $(2+x+y^3)^4 \neq 2^4+x^4+y^{12}$

NOT $(2+x+y^3)^4 \neq 2^4 + x^4 + y^{12}$

Example: $\left(\frac{2}{3}\right)^3 = \frac{2^3}{3^3} = \frac{8}{27}$

Summary:

Exponent Rules

The Product Rule for Exponents
(Multiplying Like Bases With Exponents)

When you multiply like bases you add your exponents.

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

$$2^3 \bullet 2^5 = 2^{3+5} = 2^8$$

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

Quotient Rule for Exponents
(Dividing Like Bases With Exponents)

When you divide like bases you subtract their exponents.

$$a^m \div a^n = a^{m-n}$$

$$7^5 \div 7^2 = 7^{5-2} = 7^3$$

$$2^2 \div 2^5 = 2^{2-5} = 2^{-3} = \frac{1}{2^3} = \frac{1}{8}$$

Power of a Power Rule for Exponents
(Base Raised to Two Exponents)

When you raise a base to two exponents, you multiply those exponents together.

$$(a^m)^n = a^{m \times n}$$

$$(a^5)^2 = a^{5\times 2} = a^{10}$$

$$(2^2)^{-3} = 2^{2\times -3} = 2^{-6} = \frac{1}{2^6} = \frac{1}{64}$$

Power of a Product Rule for Exponents
(A Product Raised to an Exponent)

When you have a PRODUCT (not a sum or difference) raised to an exponent, you can simplify by raising each base in the product to that exponent.

$(ab)^m = a^m b^m \quad (2x^2)^3 = 2^3 x^6 = 8x^6 \quad (2x^2)^{-3} = 2^{-3} x^{-6} = \frac{1}{2^3 x^6} = \frac{1}{8x^6}$

Power of a Quotient
(A Quotient Raised to an Exponent)

When you have a QUOTIENT (not a sum or difference) raised to an exponent, you raise each base in the numerator and denominator of the quotient to that exponent.

$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} \qquad \left(\frac{x^5}{y^2}\right)^3 = \frac{x^{15}}{y^6} \qquad \left(\frac{2^3}{4}\right)^2 = \frac{2^6}{4^2} = \frac{64}{16} = 4$

Zero Exponents

Any base raised to an exponent of 0 has a value of 1.

$a^0 = 1 \qquad 100^0 = 1 \qquad 5xyz^0 = 5xy \qquad (5xyz)^0 = 1$

Negative Exponents

A base raised to a negative exponent has the same value as the reciprocal of the base to the positive of the exponent.

$a^{-4} = \left(\frac{1}{a}\right)^4 = \frac{1}{a^4} \qquad 10^{-4} = \left(\frac{1}{10}\right)^4 = \frac{1}{10^4} \qquad \left(\frac{2}{3}\right)^{-2} = \left(\frac{3}{2}\right)^2 = \frac{3^2}{2^2} = \frac{9}{4}$

Rule	Example	Notes
$a^n \cdot a^m = a^{n+m}$	$2^2 \cdot 2^3 = 2^{2+3} = 2^5$	The bases, which are the a's in this case, must be the same.
$\frac{a^n}{a^m} = a^{n-m}$	$\frac{2^5}{2^3} = 2^{5-3} = 2^2 = 4$	The bases, which are the a's in this case, must be the same.
$a^n \cdot b^n = (a \cdot b)^n$	$2^2 \cdot 3^2 = (2 \cdot 3)^2 = (6)^2 = 36$	The exponents, which are the n's in this case, must be the same.
$\frac{a^n}{b^n} = \left(\frac{a}{b}\right)^n$	$\frac{2^2}{3^2} = \left(\frac{2}{3}\right)^2 = \frac{2}{3} \cdot \frac{2}{3} = \frac{4}{9}$	The exponents, the n's in this case, must be the same.
$(b^n)^m = b^{n \cdot m}$	$(2^3)^2 = 2^{3 \cdot 2} = 2^6 = 64$	Alternatively, we can use the first rule: $(2^3)^2 = 2^3 \cdot 2^3 = 2^{3+3} = 2^6$
$a^{-m} = \frac{1}{a^m}$	$2^{-3} = \frac{1}{2^3} = \frac{1}{8}$	In order to solve, we must change negative exponents into positives with this method.
$\sqrt[m]{a^n} = a^{n/m}$	$\sqrt[3]{2^2} = 2^{2/3}$	In some situations, we must change radicals into exponents with this method.
$a^0 = 1$	$\left(\frac{1}{2}\right)^0 = 1,\ 3^0 = 1, \ldots$	Any number raised to the power of zero is equal to 1.
$a^1 = a$	$\left(\frac{1}{4}\right)^1 = \frac{1}{4},\ 6^1 = 6, \ldots$	Any number raised to the power of 1 is equal to itself.

Pre Calculus 12 *Unit 4 Exponents and Logarithms*

Lesson 1 Assignment
Review The Laws of Exponents

1.) Simplify the following and write answers with positive exponents only.

a) $-3x^{-2}y^5$ b) $\frac{24a^2}{3a^5}$ c) $\frac{16a^{-3}}{48a^{-7}b^2}$ d) $\left(3x^{-3}y^2\right)\left(-4x^{-2}y^{-7}\right)$ e) $\left(-2m^4n^{-3}\right)^{-3}$

f) $\frac{-m^{-3}\left(n^{-2}\right)^3}{n^5\left(m^3\right)^2}$ g) $\left(\frac{2a^{-3}b^2}{3a^4b^{-1}}\right)^{-2}$ h) $5x^{-4}y^3 \times \left(15x^{-2}y^3\right)^{-1}$ i) $\frac{\left(15a^{-2}\right)\left(18a^{-5}\right)}{30a^{-8}}$ j) $\frac{7a^{-4}bc^3}{\left(2a^{-2}b^4c^{-1}\right)^3}$

2.) Find the exact value of the following.

a) 7^{-3} b) $32^{\frac{2}{5}}$ c) $\left(\frac{3}{7}\right)^{-2}$ d) $\left(\frac{1}{6}\right)^{-3}$

Change the base of an exponential expression or equation:

3.) Evaluate the expressions for, $x=-1,\ y=2,\ z=3$.

a) $\left(2x^{-1}y^{-3}z\right)\left(3x^{2}y^{3}z^{-1}\right)$

b) $\dfrac{\left(2x^{2}y^{4}z^{-2}\right)^{3}}{4x^{4}y^{10}z^{-4}}$

4.) Convert the following to the indicated base.

a) 25^{-3x} to base 5.

b) 64^{a+4} to base 4.

c) $\dfrac{1}{216^{3x}}$ to base 6.

d) $\left(\dfrac{1}{32}\right)^{a+1}$ to base 2.

e) $\left(\dfrac{81}{49}\right)^{2a}$ to base $\dfrac{3}{7}$.

ANSWERS

1a. $\dfrac{-3y^{5}}{x^{2}}$ 1b. $\dfrac{8}{a^{3}}$ 1c. $\dfrac{a^{4}}{3b^{2}}$ 1d. $\dfrac{-12}{x^{5}y^{5}}$ 1e. $-\dfrac{n^{9}}{8m^{12}}$ 1f. $\dfrac{-1}{m^{9}n^{11}}$ 1g. $\dfrac{9a^{14}}{4b^{6}}$ 1h. $\dfrac{1}{3x^{2}}$

1i. $9a$ 1j. $\dfrac{7a^{2}c^{6}}{8b^{11}}$

2a. $\dfrac{1}{343}$ 2b. 4 2c. $\dfrac{49}{9}$ 2d. 216

3a. -6 3b. $\dfrac{8}{9}$

4a. 5^{-6x} 4b. 4^{3a+12} 4c. 6^{-9x} 4d. 2^{-5a-5} 4e. $\dfrac{3^{8a}}{7^{4a}}$

Solving Exponents

RECALL:

Rules of Exponents or Laws of Exponents	
Multiplication Rule	$a^x \times a^y = a^{x+y}$
Division Rule	$a^x \div a^y = a^{x-y}$
Power of a Power Rule	$(a^x)^y = a^{xy}$
Power of a Product Rule	$(ab)^x = a^x b^x$
Power of a Fraction Rule	$\left(\frac{a}{b}\right)^x = \frac{a^x}{b^x}$
Zero Exponent	$a^0 = 1$
Negative Exponent	$a^{-x} = \frac{1}{a^x}$
Fractional Exponent	$a^{\frac{x}{y}} = \sqrt[y]{a^x}$

Solving when the base is a variable x:

Example 1 Solve the following equation for x.

$$x^{\frac{3}{2}} = 125$$

Example 2 Solve the following equation for x.

$$2x^{\frac{3}{4}} = 54$$

Example 3 Solve the following equation for x.

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

When the variable is in the exponent:

- **convert each base to the same base**

Exponential Equations with Same Base

$a^x = a^y$ If and only if $x = y$

Examples:

$2^x = 64$
$\Rightarrow 2^x = 2^6$
$\Rightarrow x = 6$

$3^{2x} = 27^{x-4}$
$\Rightarrow 3^{2x} = \left(3^3\right)^{x-4}$
$\Rightarrow 2x = 3(x-4)$
$\Rightarrow 2x = 3x - 12$
$\Rightarrow -x = -12$
$\Rightarrow x = 12$

https://slideplayer.com/slide/6897597/

Solve by Equating Exponents

Solve $4^{3x} = 8^{x+1}$	Original Problem
$\left(2^2\right)^{3x} = \left(2^3\right)^{x+1}$	Rewrite with base 2
$2^{6x} = 2^{3x+3}$	Simplify exponents
$6x = 3x + 3$	Equate exponents
$x = 1$	Simplify

Goal 1: Solving Exponential Functions

Solving Exponential Equations:

- If possible, express both sides as powers of the same base
- Equate the exponents
- Solve for variable

$27(3^{x+1}) = 9^{2x-7}$
$3^3(3^{x+1}) = (3^2)^{2x-7}$
$3^{3+x+1} = 3^{2(2x-7)}$
$3^{x+4} = 3^{4x-14}$

$x + 4 = 4x - 14$

$4 = 3x - 14$
$18 = 3x$
$\boxed{x = 6}$

Solve: $\left(\frac{2}{3}\right)^{x+6} = \left(\frac{8}{27}\right)^{3x}$

1. Find a common base

$\frac{8}{27} = \left(\frac{2}{3}\right)^3$

$\left(\frac{2}{3}\right)^{x+6} = \left[\left(\frac{2}{3}\right)^3\right]^{3x}$

$\left(\frac{2}{3}\right)^{x+6} = \left(\frac{2}{3}\right)^{9x}$

2. Equate the exponents

$x + 6 = 9x$

$x = \frac{3}{4}$

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Example 1 Simplify $\frac{4^{6x+1}}{8^{4x+2}}$

Example 2 Solve $9^{2x-3} = 27^{1-x}$

Example 1 Solve the following equation for x .

$$2^{3x-1} = 16$$

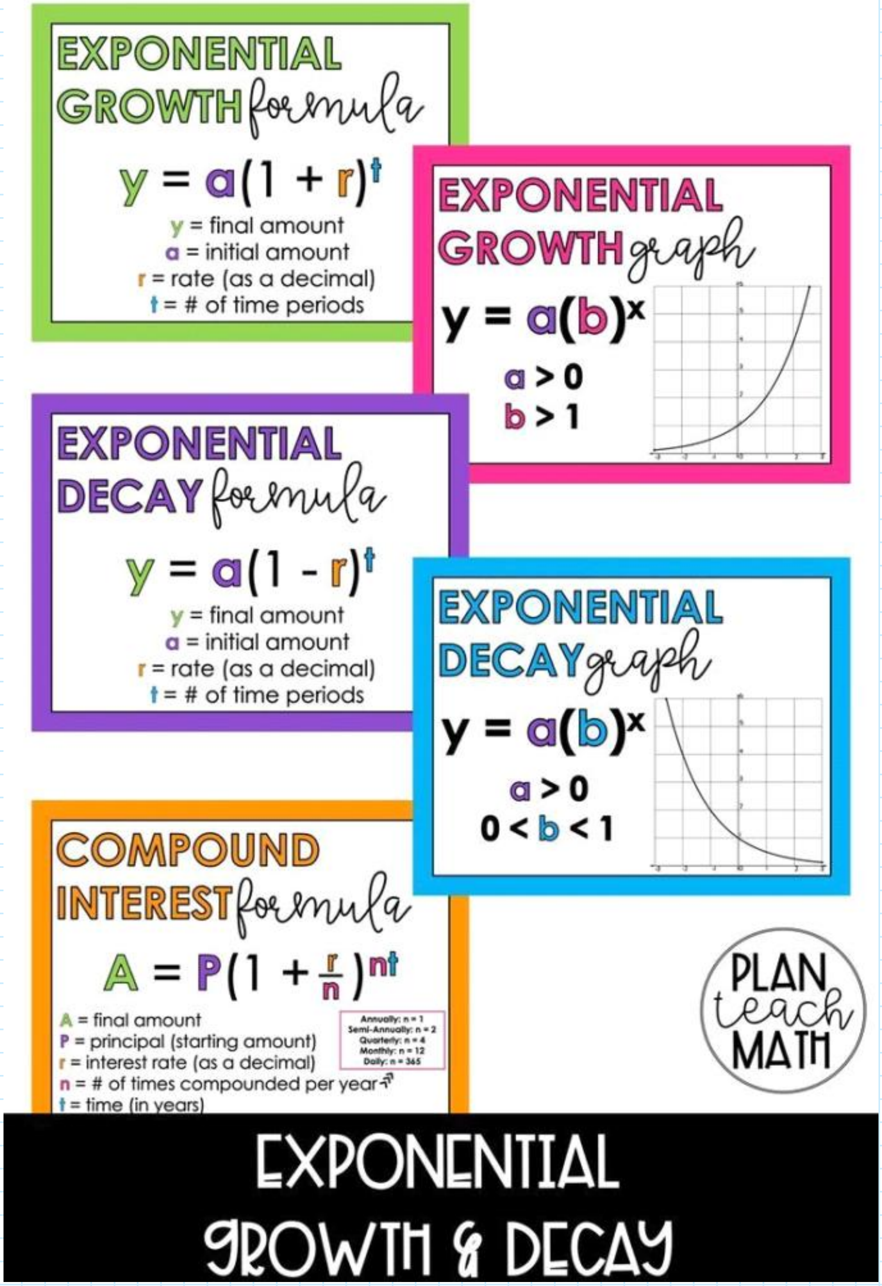
Example 2 Solve the following equation for x .

$$27^{2x-1} = 9^{x+2}$$

Example 3 Solve the following equation for x .

$$\frac{1}{343^{x-1}} = 49^{2x-1}$$

APPLICATIONS



EXPONENTIAL GROWTH formula
y = a(1 + r)^t
y = final amount
a = initial amount
r = rate (as a decimal)
t = # of time periods
EXPONENTIAL GROWTH graph
y = a(b)^x
a > 0
b > 1
EXPONENTIAL DECAY formula
y = a(1 - r)^t
y = final amount
a = initial amount
r = rate (as a decimal)
t = # of time periods
EXPONENTIAL DECAY graph
y = a(b)^x
a > 0
0 < b < 1
COMPOUND INTEREST formula
A = P(1 + r/n)^nt
A = final amount
P = principal (starting amount)
r = interest rate (as a decimal)
n = # of times compounded per year
t = time (in years)
Annually: n = 1
Semi-Annually: n = 2
Quarterly: n = 4
Monthly: n = 12
Daily: n = 365
PLAN teach MATH
EXPONENTIAL GROWTH & DECAY

Exponential growth and decay can be modeled using the formula: $A = A_o(b)^{\frac{t}{n}}$

A = final amount
A_o = initial amount
b = base which is the factor of change (growth or decay factor)
t = time elapsed
n = interval of time for growth or decay

Compound Interest: $A = P(1+i)^{tn}$ OR $A = P\left(1+\frac{r}{n}\right)^{tn}$

P = Principal (initial amount)
i = Interest rate divided by the number of times compounded per year
n = number of compounding periods per year

Richter Scales for Earthquakes:

$$I = I_o(10)^{R_{high} - R_{low}}$$

I = the intensity between the two Richter scale magnitudes
R = difference in Richter scale magnitudes where 1 unit represents a 10-fold increase or decrease in magnitude.

Decibel Scale:

$$I = I_o(10)^{\frac{Db_{high} - Db_{low}}{10}}$$

I = the intensity of sound between the two decibel levels
Db = difference in decibel scale levels where 10 units represent a 10-fold increase or decrease in decibel level.

pH Scale:

$$I = I_o(10)^{pH_{high} - pH_{low}}$$

I = the level of acidity or basicity between the two pH values
pH = difference in values on pH scale where 1 unit represents a 10-fold increase or decrease in pH level (translates to change in acidity of a solution; either more or less acidic or basic).

The growth and decay formula is another variation of $f(x) = A(a^x)$.

Growth and Decay Formulas

$A = A_0(x)^{\frac{t}{T}}$	$A = A_0e^{kt}$
A: final amount	A: final amount
A_0: initial amount	A_0: initial amount
x: growth or decay value*	e: constant ≈ 2.71828
t: total time remaining	k: proportional constant
T: time of growth or decay by factor of x**	t: time

*for half-life questions, use $x = \frac{1}{2}$
for increasing by 10%, use $1 + .1 = 1.1$
for decreasing by 10%, use $1 - .1 = 0.9$
**for half-life questions, T = half-life

Example 7 The half-life of plutonium-239 is about 25 000 years. How much of a given sample will remain after 2000 years?

Example 8 The number of fruit flies increases by 25% every 3 days. If the population was 2000 fruit flies after 25 days, how many were there initially?

Solving Extra Practice

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Exponential Equations Not Requiring Logarithms

Date________________ Period____

Solve each equation.

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

2) $5^{3-2x} = 5^{-x}$

3) $3^{1-2x} = 243$

4) $3^{2a} = 3^{-a}$

5) $4^{3x-2} = 1$

6) $4^{2p} = 4^{-2p-1}$

7) $6^{-2a} = 6^{2-3a}$

8) $2^{2x+2} = 2^{3x}$

9) $6^{3m} \cdot 6^{-m} = 6^{-2m}$

10) $\dfrac{2^x}{2^x} = 2^{-2x}$

11) $10^{-3x} \cdot 10^x = \dfrac{1}{10}$

12) $3^{-2x+1} \cdot 3^{-2x-3} = 3^{-x}$

13) $4^{-2x} \cdot 4^{x} = 64$

14) $6^{-2x} \cdot 6^{-x} = \frac{1}{216}$

15) $2^{x} \cdot \frac{1}{32} = 32$

16) $2^{-3p} \cdot 2^{2p} = 2^{2p}$

17) $64 \cdot 16^{-3x} = 16^{3x-2}$

18) $\frac{81^{3n+2}}{243^{-n}} = 3^{4}$

19) $81 \cdot 9^{-2b-2} = 27$

20) $9^{-3x} \cdot 9^{x} = 27$

21) $\left(\frac{1}{6}\right)^{3x+2} \cdot 216^{3x} = \frac{1}{216}$

22) $243^{k+2} \cdot 9^{2k-1} = 9$

23) $16^{r} \cdot 64^{3-3r} = 64$

24) $16^{2p-3} \cdot 4^{-2p} = 2^{4}$

Kuta Software - Infinite Algebra 2 Name________________________________

Exponential Equations Not Requiring Logarithms

Date________________ Period____

Solve each equation.

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

$\left\{-\frac{3}{2}\right\}$

2) $5^{3-2x} = 5^{-x}$

$\{3\}$

3) $3^{1-2x} = 243$

$\{-2\}$

4) $3^{2a} = 3^{-a}$

$\{0\}$

5) $4^{3x-2} = 1$

$\left\{\frac{2}{3}\right\}$

6) $4^{2p} = 4^{-2p-1}$

$\left\{-\frac{1}{4}\right\}$

7) $6^{-2a} = 6^{2-3a}$

$\{2\}$

8) $2^{2x+2} = 2^{3x}$

$\{2\}$

9) $6^{3m} \cdot 6^{-m} = 6^{-2m}$

$\{0\}$

10) $\frac{2^x}{2^x} = 2^{-2x}$

$\{0\}$

11) $10^{-3x} \cdot 10^{x} = \frac{1}{10}$

$\left\{\frac{1}{2}\right\}$

12) $3^{-2x+1} \cdot 3^{-2x-3} = 3^{-x}$

$\left\{-\frac{2}{3}\right\}$

13) $4^{-2x} \cdot 4^{x} = 64$

$\{-3\}$

14) $6^{-2x} \cdot 6^{-x} = \frac{1}{216}$

$\{1\}$

15) $2^{x} \cdot \frac{1}{32} = 32$

$\{10\}$

16) $2^{-3p} \cdot 2^{2p} = 2^{2p}$

$\{0\}$

17) $64 \cdot 16^{-3x} = 16^{3x-2}$

$\left\{\frac{7}{12}\right\}$

18) $\frac{81^{3n+2}}{243^{-n}} = 3^{4}$

$\left\{-\frac{4}{17}\right\}$

19) $81 \cdot 9^{-2b-2} = 27$

$\left\{-\frac{3}{4}\right\}$

20) $9^{-3x} \cdot 9^{x} = 27$

$\left\{-\frac{3}{4}\right\}$

21) $\left(\frac{1}{6}\right)^{3x+2} \cdot 216^{3x} = \frac{1}{216}$

$\left\{-\frac{1}{6}\right\}$

22) $243^{k+2} \cdot 9^{2k-1} = 9$

$\left\{-\frac{2}{3}\right\}$

23) $16^{r} \cdot 64^{3-3r} = 64$

$\left\{\frac{6}{7}\right\}$

24) $16^{2p-3} \cdot 4^{-2p} = 2^{4}$

$\{4\}$