

2-6-3 Exponent Rules

Remember: $3^4 = 3(3)(3)(3)$ so $3^4(3^3) = 3(3)(3)(3)(3)(3)(3) = 3^7$

$x^5x^3 = xxxxxxxx = x^8$ and $2^3s^23^2s^5 = 8ss9sssss = 72sssssss = 72s^7$

Rule: $a^m a^n = a^{m+n}$

so $f^{52} f^{123} = f^{175}$

and $2w^{1/8} 3w^{3/4} = 6w^{7/8}$

(don't worry what fractional exponents mean...yet.)

When multiplying like bases, add the exponents. $3y^3z4y^5z^5 = 12y^{3+5}z^{1+5} = 12y^8z^6$

Practice: Simplify.

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|---------------------------|------------------------------|-----------------------------|--------------------------------------|
| a) $a^1 a^1 =$ | c) $c^2 c^7 =$ | e) $e^2 e^2 =$ | g) $g^9 g^7 =$ |
| b) $b^6 b^3 =$ | d) $d^5 d^1 =$ | f) $f^4 f^8 =$ | h) $h^5 h^5 =$ |
| c) $a^{10} a^{10} =$ | e) $c^{25} c^{33} =$ | g) $e^{71} e^{53} =$ | i) $g^{29} g^{47} =$ |
| d) $b^{600} b^{30} =$ | f) $d^{-5} d^1 =$ | h) $f^N f^N =$ | j) $h^{6/3} h^{5/2} =$ |
| e) $4a^1 4a^1 =$ | g) $8c^2 5c^7 =$ | i) $2e^2 2e^2 =$ | k) $Ng^9 Ng^7 =$ |
| f) $4b^7 7b^4 =$ | h) $3d^5 9d^2 =$ | j) $3^4 f^3 4^3 f^8 =$ | l) $3^{(3+1)} h^7 3^4 h^5 =$ |
| g) $2^5 y^3 3^2 a =$ | i) $4^2 c^3 5^2 c^7 =$ | k) $Go^M Et^s =$ | m) $4^4 g^4 4^4 g^4 =$ |
| h) $3^6 b^6 b^3 =$ | j) $5^2 d^5 4d^1 =$ | l) $4^3 f^4 6^3 f^8 =$ | n) $5^2 h^5 5^5 h^5 =$ |
| i) $3a^1 x^2 a^2 x^1 3 =$ | k) $4x^3 c^5 x^9 10c^7 =$ | m) $(9+1)xe^4 x^{10} e^4 =$ | o) $1.5x^{1.1} g^9 7.5x^{2.1} g^6 =$ |
| j) $x^5 2b^5 2x^3 b^3 =$ | l) $x^{3.4} d^5 x^3 d^2 5 =$ | n) $7x^6 f^4 x^9 f^9 =$ | p) $4x^6 h^7 x^9 h^2 =$ |

Remember how to cancel. Make a 1 out of common factors. $\frac{14(6)}{4(15)} = \frac{7(2)}{2(5)} = \frac{7}{5}$

$$\frac{r^5}{r^3} = \frac{rrrrr}{rrr} = \frac{\cancel{r}\cancel{r}\cancel{r}rr}{\cancel{r}\cancel{r}\cancel{r}} = \frac{rr}{1} = r^2$$

$$\frac{h^3}{h^6} = \frac{\cancel{h}\cancel{h}\cancel{h}}{\cancel{h}\cancel{h}\cancel{h}hhh} = \frac{1}{hhh} = \frac{1}{h^3}$$

$$\frac{a^3 b^2}{a^2 b^4} = \frac{aaabb}{aabbbb} = \frac{\cancel{a}\cancel{a}ab\cancel{b}}{\cancel{a}\cancel{a}\cancel{b}\cancel{b}bb} = \frac{a}{bb} = \frac{a}{b^2}$$

Rule: $\frac{a^m}{a^n} = a^{m-n}$

$$\frac{k^{543}}{k^{215}} = k^{543-215} = k^{328}$$

$$\frac{12s^{25}}{20s^{16}} = \frac{3}{5} s^9$$

When dividing like bases, subtract the exponents.

Review the examples. $\frac{r^5}{r^3} = \frac{rrrrr}{rrr} = \frac{\cancel{r}\cancel{r}\cancel{r}rr}{\cancel{r}\cancel{r}\cancel{r}} = \frac{rr}{1} = r^2$ is the same as r^{5-3}

Practice: Simplify.

a)	$\frac{w^4}{w^2} =$	$\frac{e^5}{e^3} =$	$\frac{r^8}{r^2} =$	$\frac{y^7}{y^5} =$	$\frac{p^{12}}{p^8} =$
b)	$\frac{q^5}{q^4} =$	$\frac{t^8}{t^3} =$	$\frac{w^4}{w^4} =$	$\frac{x^{21}}{x^{21}} =$	$\frac{b^{14}}{b^{13}} =$
c)	$\frac{q^{24}}{q^{10}} =$	$\frac{x^{54}}{x^{110}} =$	$\frac{m^{45}}{m^{73}} =$	$\frac{w^{84}}{w^{92}} =$	$\frac{f^{31}}{f} =$
d)	$\frac{4e^7}{12e^2} =$	$\frac{14f^{14}}{21f^{12}} =$	$\frac{45x^{64}}{9x^{54}} =$	$\frac{144k^{12}}{60k^5} =$	$\frac{72h^{46}}{56h^{45}} =$
e)	$\frac{2x^3 5x^5}{15x^4} =$	$\frac{15y^{13} 21y^{52}}{3^2 x^{45}} =$	$\frac{4a^{25} 5a^8}{20a^{30}} =$	$\frac{12a^5 56a^{81}}{64a^{50}} =$	$\frac{3x^3 2x^2}{5x^5} =$

Notice what happens with the example $\frac{h^3}{h^6} = \frac{\cancel{h}\cancel{h}\cancel{h}}{\cancel{h}\cancel{h}\cancel{h}hhh} = \frac{1}{hhh} = \frac{1}{h^3} = h^{3-6} = h^{-3}$

This leads to another rule.

$$s^{-3} = \frac{1}{s^3} \quad \text{and} \quad \frac{1}{d^{-5}} = d^5$$

Rule: $a^{-n} = \frac{1}{a^n}$ and $\frac{1}{a^{-n}} = a^n$

Practice: Write each answer two ways, as a fraction with positive exponents and without using fractions but using negative exponents.

f)	$\frac{w^4}{w^7} = w^{-3} \text{ or } \frac{1}{w^3}$	$\frac{x}{x^5} =$	$\frac{w^{32}}{w^{34}} =$	$\frac{w^4}{w^2} =$
g)	$\frac{a^7}{a^{12}} =$	$\frac{q^{41}}{q^{52}} =$	$\frac{s^4}{s^5} =$	$\frac{z^{14}}{z^{15}} =$

$$\frac{36r^2 r^5 s^{12}}{45r^7 s^7} = \frac{9 \cdot 4 \cdot 2rr^5 s^{12}}{9 \cdot 5r^7 s^7} = \frac{8r^6 s^{12}}{5r^7 s^7} = \frac{8}{5} r^{6-7} s^{12-7} = \frac{8s^5}{5r} = \frac{8}{5} r^{-1} s^5$$

h)	$\frac{3e^3}{4e^6}$	$\frac{7f^7}{4f^6}$	$\frac{9p^3}{3p^5}$	$\frac{36y^{13}}{6y^{16}}$
i)	$\frac{30j^{30}}{25j^{60}}$	$\frac{j^3}{5j^{10}}$	$\frac{12t^8}{15t^{15}}$	$\frac{56r^{98}}{48r^{123}}$
j)	$\frac{28x^5 y^5}{21x^3 y^7}$	$\frac{81m^3 n^5}{144m^3 n^7}$	$\frac{35s^2 t^5}{21s^3 t^{17}}$	$\frac{32x^{51} y^{15}}{12x^{30} y^{71}}$
k)	$\frac{15m^3 3m^3}{45m^6}$	$\frac{25m^5 33m^5}{55m^{10}}$	$\frac{6p^{13} 10p^{13}}{8p^{16}}$	$\frac{15t^3 60t^3}{45t^7}$

l) $\frac{32t^{16}}{56t^{25}}$	$\frac{2t}{6t}$	$\frac{42e^{65}}{48e^{79}}$	$\frac{12t^{90}}{48t^{205}}$
m) $\frac{10k^{12}l^{51}}{45k^{36}l^{27}}$	$\frac{k^{31}l}{5k^{36}l^7}$	$\frac{30k l^{52}}{10k^{36}l^3}$	$\frac{24f^{12}e^{41}}{4e^{26}f^{27}}$
n) $\frac{3m^{14}3m^{13}}{45m^{61}}$			

$$\frac{x^3}{x^3} = x^{3-3} = x^0 \text{ or all cancel for an answer of 1.}$$

Rule: $a^0 = 1$

Anything to the zero power is 1.

Practice: Simplify

o) $3^0 =$	$x^0 =$	$(4y)^0 =$	$(3st^5)^0 =$	$(5-8+9-7-12)^0 =$
p) $4x^0 =$	$8e^0 =$	$2s5x^0 =$	$2(3st^5)^0$	$\frac{1}{2} (3st^5)^0$

Rule: $(a^m)^n = a^{mn}$
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$$(x^3)^5 = x^3 x^3 x^3 x^3 x^3 = x^{3 \cdot 5} = x^{15} \text{ using a previous rule.}$$

An easier way would be to multiply the 3 and 5 to get the new exponent of 15.

Practice: Simplify.

q) $(s^2)^3 =$	$(x^{12})^3 =$	$(w^4)^5 =$	$(x^3)^5 =$
r) $(x^{21})^3 =$	$(y^{25})^4 =$	$(m^{\frac{7}{3}})^{\frac{3}{2}} =$	$(u^{52})^6 =$
s) $(2x^2)^3 =$	$(5r^5)^4 =$	$(3t^2)^5 =$	$(3x^{12})^2 =$
t) $(4a^2b^5c)^3 = 64a^6b^{15}c^3$	$(3d^5e^5f)^4 =$	$(2u^2v^5u)^5 =$	$(4a^{21}2b^{51})^2$
u) $\left(\left(\frac{2}{5}\right)^2\right)^2 =$	$\left((2.5)^2\right)^3 =$	$(0.2x^5 \cdot 0.5x^3)^2 =$	$(0.5r^3 \cdot 1.2r^4)^3$
v) $\left(\frac{3xy^3}{6x^5y^2}\right)^2 =$	$\left(\frac{x^5y^3}{x^5y^2}\right)^3 =$	$\left(\frac{56kl^3 \cdot 10k^3}{16k^8l^2 \cdot 14k^{10}}\right)^2 =$	$\left(\frac{12a^3 \cdot 4a^5b^3}{6a^8b^5}\right)^2 =$

Notice: $5x^3 + 3x^2$ are not like terms and cannot be combined.

Contrast this with $5x^3 3x^4 = 15x^7$ The multiplication can be done.

$4m^3 + 5m^3 = 9m^3$ **Don't** add the exponents. $4m^3 5m^3 = 20m^6$ **Do** add the exponents.

a) $3d^5 + 2d^5 =$ $3d^5 2d^5 =$ $2x^3 + 2x^5 =$ $2x^3 2x^5 =$

b) $7e^5 2e^5 =$ $7e^5 + 2e^5 =$ $3u^3 + 2u^5 =$ $3u^3 2u^5 =$

c) $4s-7s+8s^2 =$ $4s(-7s)(8s^2) =$ $7r^4+7r^3 =$ $7r^4(7r^3) =$

d) $3x^2 - (-4x^2) - 8x^2 =$ $3x^2(-4x^2)(-8x^2) =$ $w-6w-(-7w^2) =$ $w(-6w)(-7w^2) =$

Mixed practice: Simplify

e) $4q^3 p^{18} 5q^{-8} p^{-9} =$ $4q^3 p^{18} - 5q^{-8} p^{-9} + 4q^3 p^{18} =$ $2(3t^3)^4 (5t^2)^3$

f) $-\frac{2}{3}a - \frac{3}{4}a + \frac{5}{12}a$ $(3nm^2)^2 + 5nm^2 2nm^2 =$ $4e^2 - 7e^3 + 3e =$

g) $\left(\frac{36x^8 y^3}{48x^7 y^{12}}\right)^4 =$ $\frac{3a^2}{5} \left(3\frac{1}{3}a\right) =$ $\frac{(2w^3)^2 - 7w3w^5}{34w^3} =$

h) $3x^2 4x^2 - 7x^2 =$ $(4e^2)(-7e^3)(3e) =$ $(-3s^5)^3 5s^4 =$

i) $\frac{\frac{2}{5}y^6 z^{\frac{6}{7}}y^3}{\frac{12}{15}y^5 z^4} =$ $\frac{5x2x^4 y5x^3}{(10xy)^5} =$ $\frac{7h^5}{3} - \frac{18h^9}{5(h^2)^2} =$

j) $\frac{3}{8}t^2 - \frac{3}{8}t^3 - \frac{2}{3}t^3 =$ $(\frac{3}{8}t^2)(-\frac{3}{8}t^3)(-\frac{2}{3}t^3) =$ $(\frac{3}{10}x^3)^3 - x^9 =$