Key

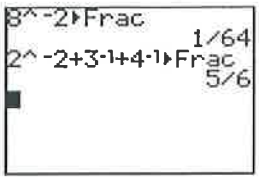
Properties of Exponents – A Summary

Let a and b be nonzero real numbers, and m, n and p be integers.

1. $b^m b^n = b^{m+n}$
2. $\dfrac{b^m}{b^n} = b^{m-n}$
3. $(b^m)^n = b^{m \cdot n}$
4. $(a^m b^n)^p = a^{mp} b^{np}$
5. $\left(\dfrac{a^m}{b^n}\right)^p = \dfrac{a^{mp}}{b^{np}}$
6. $b^0 = 1$
7. $b^{-n} = \dfrac{1}{b^n}$ and $\dfrac{1}{b^{-n}} = b^n$

Example 5

Simplify each of the following.



1. 8^{-2} $\frac{1}{64}$
2. $\dfrac{-2}{x^{-3}}$ $-2x^3$
3. $2^{-2} + 3^{-1} + 4^{-1}$ $\frac{1}{4} + \frac{1}{3} + \frac{1}{4} = \frac{5}{6}$
4. $\dfrac{c^{-2}}{3^{-3} c^{-3}}$ $27c$

Example 6

1. Simplify $\dfrac{2a^{-5}}{a^{-3}}$ $\dfrac{2}{a^2}$

2. Simplify $\dfrac{35x^{-9}y^{2}}{7x^{-5}y^{-3}}$ $\dfrac{5y^5}{x^4}$

3. Simplify $\left(\dfrac{18b^{-3}c^{7}}{9b^{-5}c^{-2}}\right)^{-4}$ $\left(\dfrac{2b^2c^9}{1}\right)^{-4} = \dfrac{1}{16b^8c^{36}}$

4. Simplify $(-2x+4y)^0+(5a-4b)^0$ 2

5. Simplify $x^{2n}x^{5n}$ x^{7n}

6. Simplify $a^{3-2n}a^{4+n}$ a^{7-n}

7. Simplify $\dfrac{(24a^3b^{-5})(42a^{-1}b^{-3})}{(-28a^2b^3)(14a^{-5}b)}$ $-\dfrac{18a^5}{7b^{12}}$

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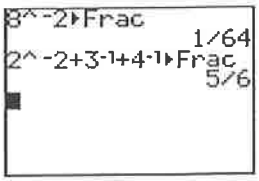

1. 8^{-2}
2. $\dfrac{-2}{x^{-3}}$
3. $2^{-2} + 3^{-1} + 4^{-1}$
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Example 6

1. Simplify $\dfrac{2a^{-5}}{a^{-3}}$

2. Simplify $\dfrac{35x^{-9}y^{2}}{7x^{-5}y^{-3}}$

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5. Simplify $x^{2n}x^{5n}$

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7. Simplify $\dfrac{(24a^{3}b^{-5})(42a^{-1}b^{-3})}{(-28a^{2}b^{3})(14a^{-5}b)}$

Properties of Exponents

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Examples: Multiply and Simplify

a) $7^2 \cdot 7^5 = 7^{2+5} = 7^7$

b) $(-2x^2y)\cdot(4xy^3) = -8x^{2+1}y^{1+3} = -8x^3y^4$

Divide and Simplify

a) $\frac{8^5}{8^2} = 8^{5-2} = 8^3$

b) $\frac{-18x^2y^4}{-3xy^2} = 6x^{2-1}y^{4-2} = 6xy^2$

Multiply and Simplify (Leave the answer in exponential notation).

1. $3^4 \cdot 3^2$ 3^6
2. $4^6 \cdot 4$ 4^7
3. $9^3 \cdot 9^2$ 9^5
4. $f^4 \cdot f^5$ f^9
5. $r^2 \cdot r^6$ r^8
6. $(-e^3)(e^5)$ $-e^8$
7. $(z^2)(-8r^2)(z^3r)$ $-8r^3z^5$
8. $(5x^2)(2xy)$ $10x^3y$
9. $(-3n^3)(-4n^2)$ $12n^5$
10. $(6x^4)(3x^2)$ $18x^6$
11. $(4a^7)(-3a^2b^3)$ $-12a^9b^3$
12. $(8x^3y^6)(-5y^3x)$ $-40x^4y^9$
13. $(4n^2y)(3xy^2)$ $12n^2xy^3$
14. $(x^2y^3)(-5y^2x^3)$ $-5x^5y^5$

Divide and Simplify.

15. $\frac{b^3}{b}$ b^2
16. $\frac{4x^2}{3x}$ $\frac{4x}{3}$
17. $\frac{5x^4}{x^2}$ $5x^2$
18. $\frac{13n^5}{7n^2}$ $\frac{13n^3}{7}$
19. $\frac{6n^3}{4n^2}$ $\frac{3n}{2}$
20. $\frac{4y^4}{2y^3}$ $2y$
21. $\frac{-5a^8}{6a^2}$ $\frac{-5a^6}{6}$
22. $\frac{-15n^6}{5n^2}$ $-3n^4$
23. $\frac{22x^5}{18x^3}$ $\frac{11x^2}{9}$
24. $\frac{14x^3y^2z^4}{-2xy^2z^3}$ $-7x^2z$
25. $\frac{18a^4b^8c^6}{6a^2b^3c}$ $3a^2b^5c^5$
26. $\frac{16a^4b^7c^6}{5a^2b^5c}$ $\frac{16a^2b^2c^5}{5}$

Simplify.

27. $(1)^{-8}$ 1
28. $(-4)^5$ -1024
29. $(-5)^3$ -125
30. $(6)^{-3}$ $1/216$
31. $(-4)^{-2}$ $1/16$
32. $(-2)^9$ -512
33. $(-6)^{-3}$ $-1/216$
34. $(-9)^4$ 6561
35. $(-3)^6$ 729
36. $(4)^{-5}$ $1/1024$
37. $(3)^{-7}$ $1/2187$
38. $(-1)^{-8}$ 1

Write an equivalent expression without negative exponents.

39. a^{-3} $\frac{1}{a^3}$

40. $\frac{x^{-3}}{5xy^2}$ $\frac{1}{5x^4y^2}$

41. $x^{-4}y^{-2}$ $\frac{1}{x^4y^2}$

42. $\frac{(4x)^{-3}}{y^4}$ $\frac{1}{64x^3y^4}$

43. $(4c^5x^2)^{-2}$ $\frac{1}{16c^{10}x^4}$

44. $\frac{2y^2}{4x^2y^3}$ $\frac{1}{2x^2y}$

45. $(df^3)^{-4}$ $\frac{1}{d^4f^{12}}$

46. $\frac{x^3y^2z^5}{z^4x^5}$ $\frac{y^2z}{x^2}$

47. $3f^3n^{-7}$ $\frac{3f^3}{n^7}$

48. $(m^4y^6)^{-3}$ $\frac{1}{m^{12}y^{18}}$

49. $5m^4c^2x^{-3}y^2$ $\frac{5c^2m^4y^2}{x^3}$

Write an equivalent expression with negative exponents.

50. $\frac{1}{2^4}$ 2^{-4}

51. $\frac{3}{2^2}$ $3\cdot2^{-2}$

52. $\frac{1}{(-3)^3}$ $(-3)^{-3}$

53. $5x^{-2}$ $5x^{-2}$

54. n^5 $\frac{1}{n^{-5}}$

55. $\frac{1}{y^2}$ y^{-2}

56. $\frac{-3}{(2y)^3}$ $-3(2y)^{-3}$

57. $\frac{1}{(2x)^2}$ $(2x)^{-2}$

Simplify. Use only positive exponents.

58. $5^3\cdot5^{-4}$ $\frac{1}{5}$

59. $6^4(-6)^2$ $6^6 = 46656$

60. $x^4\cdot x^{-5}$ $\frac{1}{x}$

61. $(4x^2)(3x^2y^3)$ $12x^4y^3$

62. $(8a^{-3}b^2)(b^2a^3c)$ $8b^4c$

63. $(5xy^2)(3y^3z)$ $15xy^5z$

64. $\frac{3x^2y^3}{2yx^3}$ $\frac{3y^2}{2x}$

65. $\frac{4a^2bc^4}{3a^4cm^3}$ $\frac{4bc^3}{3a^2m^3}$

66. $\frac{((4x)^{-3})(3x^2)}{xy^2}$ $\frac{3}{64x^2y^2}$

67. $\frac{8x^3y^2z^4}{16x^5y^3z}$ $\frac{z^3}{2x^2y}$

68. $4(a^2b^3)^4$ $4a^8b^{12}$

69. $(6x^3y^2)^{-2}$ $\frac{1}{36x^6y^4}$

70. $8(x^3y^2)^3$ $8x^9y^6$

71. $(4^{-3})^{-3}$ $4^9 = 262144$

72. $\frac{-4x^3y^5z^2}{16x^5y^7z}$ $\frac{-z}{4x^2y^2}$

73. $\frac{4a^2bc^3}{-8a^8b^4c^3d^{-5}}$ $-\frac{d^5}{2a^6b^3}$

74. $\left(\frac{3x^3y^{-4}}{4x^2y^3}\right)^{-3}$ $\frac{64y^{21}}{27x^3}$

75. $\left(\frac{14x^3y^2z^5}{7xy^3z^3}\right)^2$ $\frac{2x^4z^4}{y^2}$

76. $\left(\frac{3a^2b^3c^5}{4ab^2c^2}\right)^{-3}$ $\frac{64}{27a^3b^3c^9}$

77. $(4x^2)^6$ $4096x^{12}$

78. $(4^{x-2})(4^2)$ 4^x

79. $(5y^2x^3)^{-6}$ $\frac{1}{15625y^{12}x^{18}}$

80. $\left(\frac{(2^{-3}a^2b^3c)(4a^2xb)}{(5ab^2c^2)(x^2ab^2)}\right)^{-3}$

$\left(\frac{64a^4b^4cx}{40a^2b^4c^2x^2}\right)^{-3} = \left(\frac{a^2}{10cx}\right)^{-3} = \frac{1000c^3x^3}{a^6}$

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11. $(4a^7)(-3a^2b^3)$ _____
12. $(8x^3y^6)(-5y^3x)$ _____
13. $(4n^2y)(3xy^2)$ _____
14. $(x^2y^3)(-5y^2x^3)$ _____

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17. $\frac{5x^4}{x^2}$ _____
18. $\frac{13n^5}{7n^2}$ _____
19. $\frac{6n^3}{4n^2}$ _____
20. $\frac{4y^4}{2y^3}$ _____
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22. $\frac{-15n^6}{5n^2}$ _____
23. $\frac{22x^5}{18x^3}$ _____
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Simplify.

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32. $(-2)^9$ _____
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