

Exponents and Roots

Properties of Exponents, Part I

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1. $(3)(3)(3) = 27$

3. $-(4)(4) = -16$

$$\begin{aligned}
 5. \quad & 6 \cdot 6^2 \cdot 6^3 \cdot 6^2 \\
 &= (6 \cdot 6^2) \cdot (6^3 \cdot 6^2) \\
 &= 6^{1+2} \cdot 6^{3+2} \\
 &= 6^3 \cdot 6^5 \\
 &= 6^{3+5} \\
 &= 6^8
 \end{aligned}$$

$$\begin{aligned}
 7. \quad & (b^4)^6 \cdot b \\
 &= b^{4 \cdot 6} \cdot b \\
 &= b^{24} \cdot b \\
 &= b^{24+1} \\
 &= b^{25}
 \end{aligned}$$

$$\begin{aligned}
 9. \quad & (5w^8)^2 \\
 &= 5^2 \cdot (w^8)^2 \\
 &= 25 \cdot w^{8 \cdot 2} \\
 &= 25w^{16}
 \end{aligned}$$

$$\begin{aligned}
 11. \quad & -(4x^3)^4 \\
 &= -((4)^4 \cdot (x^3)^4) \\
 &= -(256 \cdot x^{3 \cdot 4}) \\
 &= -256x^{12}
 \end{aligned}$$

$$\begin{aligned}
 13. \quad & 2^{-1} = \frac{1}{2^1} = \frac{1}{2} \\
 & 2^{-1} \text{ oz is equal to } \frac{1}{2} \text{ oz.}
 \end{aligned}$$

$$15. -9^{-2} = -\frac{1}{9^2} = -\frac{1}{9 \cdot 9} = -\frac{1}{81}$$

$$17. 13^{-2} = \frac{1}{13^2} = \frac{1}{13 \cdot 13} = \frac{1}{169}$$

$$19. (-4)^2 = (-4)(-4) = 16$$

2. $(-4)(-4) = 16$

$$4. \left(-\frac{3}{5}\right)\left(-\frac{3}{5}\right) = \frac{9}{25}$$

$$\begin{aligned}
 6. \quad & (2^3)^3 \\
 &= 2^{3 \cdot 3} \\
 &= 2^9, \text{ or } 512
 \end{aligned}$$

$$\begin{aligned}
 8. \quad & (3x)^3 \\
 &= 3^3 \cdot x^3 \\
 &= 27x^3
 \end{aligned}$$

$$\begin{aligned}
 10. \quad & (-4x^3)^4 \\
 &= (-4)^4 \cdot (x^3)^4 \\
 &= 256 \cdot x^{3 \cdot 4} \\
 &= 256x^{12}
 \end{aligned}$$

$$\begin{aligned}
 12. \quad & (p^4q^2)^7 \\
 &= (p^4)^7 \cdot (q^2)^7 \\
 &= p^{4 \cdot 7} \cdot q^{2 \cdot 7} \\
 &= p^{28}q^{14}
 \end{aligned}$$

14. $8^0 = 1$

16. $\left(\frac{2}{5}\right)^0 = 1$

$$18. (-3)^{-1} = \frac{1}{(-3)^1} = \frac{1}{-3} = -\frac{1}{3}$$

$$20. \left(\frac{1}{2}\right)^{-2} = \frac{1}{\left(\frac{1}{2}\right)^2} = \frac{1}{\frac{1}{2} \cdot \frac{1}{2}} = \frac{1}{\frac{1}{4}} = 4$$

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$$21. -7^{-1} = -\frac{1}{7^1} = -\frac{1}{7}$$

$$\begin{aligned} 23. & b \cdot (a^3)^4 \cdot (b^{-2})^3 \\ & = b \cdot a^{3 \cdot 4} \cdot b^{-2 \cdot 3} \\ & = b \cdot a^{12} \cdot b^{-6} \\ & = (b \cdot b^{-6}) \cdot a^{12} \\ & = b^{1-6} \cdot a^{12} \\ & = b^{-5} \cdot a^{12} \\ & = \frac{1}{b^5} \cdot a^{12} \\ & = \frac{a^{12}}{b^5} \end{aligned}$$

$$\begin{aligned} 25. & (x^2)^{-1} \\ & = x^{2 \cdot (-1)} \\ & = x^{-2} \\ & = \frac{1}{x^2} \end{aligned}$$

$$\begin{aligned} 27. & (3^6)^0 \\ & = 3^{6 \cdot 0} \\ & = 3^0 \\ & = 1 \end{aligned}$$

$$\begin{aligned} 22. & a^5 \cdot a^0 \cdot a^{-5} \\ & = a^5 \cdot 1 \cdot a^{-5} \\ & = a^5 \cdot a^{-5} \\ & = a^{5-5} \\ & = a^0 \\ & = 1 \end{aligned}$$

$$\begin{aligned} 24. & x^7 \cdot x^{-6} \cdot y^{-3} \\ & = x^{7-6} \cdot y^{-3} \\ & = x \cdot \frac{1}{y^3} \\ & = \frac{x}{y^3} \end{aligned}$$

$$\begin{aligned} 26. & (x^4)^2 \cdot (x^{-1})^{-4} \\ & = x^{4 \cdot 2} \cdot x^{-1 \cdot (-4)} \\ & = x^8 \cdot x^4 \\ & = x^{8+4} \\ & = x^{12} \end{aligned}$$

$$\begin{aligned} 28. & (x^3y^4)^3 \cdot (xy^3)^{-2} \\ & = ((x^3)^3 \cdot (y^4)^3) \cdot (x^{-2} \cdot (y^3)^{-2}) \\ & = (x^3 \cdot 3 \cdot y^4 \cdot 3) \cdot (x^{-2} \cdot y^{3 \cdot -2}) \\ & = (x^9 \cdot y^{12}) \cdot (x^{-2} \cdot y^{-6}) \\ & = (x^9 \cdot x^{-2}) \cdot (y^{12} \cdot y^{-6}) \\ & = x^{9-2} \cdot y^{12-6} \\ & = x^7y^6 \end{aligned}$$

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$$\begin{aligned}
 29. \left(\frac{2}{3}\right)^{-3} &= \left(\frac{2}{3}(9)\right)^{-3} \\
 &= 6^{-3} \\
 &= \frac{1}{6^3} \\
 &= \frac{1}{6 \cdot 6 \cdot 6} \\
 &= \frac{1}{216}
 \end{aligned}$$

$$\begin{aligned}
 31. 10m^{-1}n^{-5} &= 10(10)^{-1}(-2)^{-5} \\
 &= 10 \cdot \frac{1}{10^1} \cdot \frac{1}{(-2)^5} \\
 &= 10 \cdot \frac{1}{10} \cdot \frac{1}{(-2)(-2)(-2)(-2)(-2)} \\
 &= -\frac{1}{32}
 \end{aligned}$$

$$\begin{aligned}
 33. 4w^v x^y &= 4(3)^0(-5)^0 \\
 &= 4 \cdot 1 \cdot 1 \\
 &= 4
 \end{aligned}$$

$$\begin{aligned}
 35. 2z^{-8} &= 2 \cdot z^{-8} \\
 &= 2 \cdot \frac{1}{z^8} \\
 &= \frac{2}{z^8}
 \end{aligned}$$

$$\begin{aligned}
 37. c^{-2}d &= c^{-2} \cdot d \\
 &= \frac{1}{c^2} \cdot d \\
 &= \frac{d}{c^2}
 \end{aligned}$$

$$\begin{aligned}
 39. 4x^{-6}y^{-2} &= 4 \cdot x^{-6} \cdot y^{-2} \\
 &= 4 \cdot \frac{1}{x^6} \cdot \frac{1}{y^2} \\
 &= \frac{4}{x^6 y^2}
 \end{aligned}$$

$$\begin{aligned}
 30. (10 - d)^0 &= (10 - 11)^0 \\
 &= (-1)^0 \\
 &= 1
 \end{aligned}$$

$$\begin{aligned}
 32. (3ab)^{-2} &= \left(3\left(\frac{1}{2}\right)(8)\right)^{-2} \\
 &= 12^{-2} \\
 &= \frac{1}{12^2} \\
 &= \frac{1}{12 \cdot 12} \\
 &= \frac{1}{144}
 \end{aligned}$$

$$34. k^{-4} = \frac{1}{k^4}$$

$$\begin{aligned}
 36. \frac{1}{2b^{-3}} &= \frac{1}{2} \cdot \frac{1}{b^{-3}} \\
 &= \frac{1}{2} \cdot b^3 \\
 &= \frac{b^3}{2}
 \end{aligned}$$

$$\begin{aligned}
 38. -5x^{-3} &= -5 \cdot x^{-3} \\
 &= -5 \cdot \frac{1}{x^3} \\
 &= -\frac{5}{x^3}
 \end{aligned}$$

$$\begin{aligned}
 40. \frac{r^{-5}}{s^{-1}} &= r^{-5} \cdot \frac{1}{s^{-1}} \\
 &= \frac{1}{r^5} \cdot s \\
 &= \frac{s}{r^5}
 \end{aligned}$$

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$$\begin{aligned}
 41. \frac{2f^0}{7g^{-10}} &= \frac{2}{7} \cdot f^0 \cdot \frac{1}{g^{-10}} \\
 &= \frac{2}{7} \cdot 1 \cdot g^{10} \\
 &= \frac{2g^{10}}{7}
 \end{aligned}$$

$$\begin{aligned}
 42. \frac{s^5}{t^{-12}} &= s^5 \cdot \frac{1}{t^{-12}} \\
 &= s^5 \cdot t^{12} \\
 &= s^5 t^{12}
 \end{aligned}$$

$$\begin{aligned}
 43. \frac{3w^{-5}}{x^{-6}} &= 3 \cdot w^{-5} \cdot \frac{1}{x^{-6}} \\
 &= 3 \cdot \frac{1}{w^5} \cdot x^6 \\
 &= \frac{3x^6}{w^5}
 \end{aligned}$$

$$\begin{aligned}
 44. b^0 c^0 &= b^0 \cdot c^0 \\
 &= 1 \cdot 1 \\
 &= 1
 \end{aligned}$$

$$\begin{aligned}
 45. \frac{2}{3} m^{-1} n^5 &= \frac{2}{3} \cdot m^{-1} \cdot n^5 \\
 &= \frac{2}{3} \cdot \frac{1}{m} \cdot n^5 \\
 &= \frac{2n^5}{3m}
 \end{aligned}$$

$$\begin{aligned}
 46. \frac{q^{-2} r^0}{s^0} &= q^{-2} \cdot r^0 \cdot \frac{1}{s^0} \\
 &= \frac{1}{q^2} \cdot 1 \cdot \frac{1}{1} \\
 &= \frac{1}{q^2}
 \end{aligned}$$

$$\begin{aligned}
 47. \frac{a^{-7} b^2}{c^3 d^{-4}} &= a^{-7} \cdot b^2 \cdot \frac{1}{c^3} \cdot \frac{1}{d^{-4}} \\
 &= \frac{1}{a^7} \cdot b^2 \cdot \frac{1}{c^3} \cdot d^4 \\
 &= \frac{b^2 d^4}{a^7 c^3}
 \end{aligned}$$

$$\begin{aligned}
 48. \frac{h^3 k^{-1}}{6m^2} &= \frac{1}{6} \cdot h^3 \cdot k^{-1} \cdot \frac{1}{m^2} \\
 &= \frac{1}{6} \cdot h^3 \cdot \frac{1}{k} \cdot \frac{1}{m^2} \\
 &= \frac{h^3}{6m^2 k}
 \end{aligned}$$

$$\begin{aligned}
 49. \frac{x^8 y^3}{x^3 y^3} &= x^{8-3} \cdot y^{3-3} \\
 &= x^5 \cdot y^0 \\
 &= x^5 \cdot 1 \\
 &= x^5
 \end{aligned}$$

$$\begin{aligned}
 50. \frac{x^8 y^4}{x^9 y z} &= x^{8-9} \cdot y^{4-1} \cdot z^{-1} \\
 &= x^{-1} \cdot y^3 \cdot z^{-1} \\
 &= \frac{y^3}{xz}
 \end{aligned}$$

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$$51. \left(\frac{a^4}{b^2}\right)^3 = \frac{(a^4)^3}{(b^2)^3}$$

$$= \frac{a^{12}}{b^6}$$

$$52. \left(\frac{xy^2}{x^3y}\right)^3 = (x^{1-3} \cdot y^{2-1})^3$$

$$= (x^{-2} \cdot y^1)^3$$

$$= \left(\frac{y}{x^2}\right)^3$$

$$= \frac{y^3}{(x^2)^3}$$

$$= \frac{y^3}{x^6}$$

$$53. \left(\frac{1}{7}\right)^{-3} = \left(\frac{7}{1}\right)^3$$

$$= 7^3 = 343$$

$$54. \left(\frac{x^2}{y^5}\right)^{-5} = \left(\frac{y^5}{x^2}\right)^5$$

$$= \frac{(y^5)^5}{(x^2)^5}$$

$$= \frac{y^{25}}{x^{10}}$$

$$55. \left(\frac{8w^7}{16}\right)^{-1} = \left(\frac{16}{8w^7}\right)^1$$

$$= \frac{2}{w^7}$$

$$56. \left(\frac{1}{4}\right)^{-2} \left(\frac{6x}{7}\right)^{-2} = \left(\frac{4}{1}\right)^2 \left(\frac{7}{6x}\right)^2$$

$$= 4^2 \cdot \frac{7^2}{(6x)^2}$$

$$= 16 \cdot \frac{49}{6^2 x^2}$$

$$= 16 \cdot \frac{49}{36x^2}$$

$$= \frac{196}{9x^2}$$