

D. Write the standard numeral for each of the following.

1. $8^2 = 64$

2. $5^3 = 125$

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

4. $4^{-2} = \frac{1}{4^2} = \frac{1}{16}$

5. $4^{-3} = \frac{1}{4^3} = \frac{1}{64}$

6. $(-3)^4 = 81$

7. $-3^4 = -(3)^4 = -81$

8. $\left[\frac{2}{3}\right]^2 = \left(\frac{2}{3}\right)\left(\frac{2}{3}\right) = \frac{4}{9}$

9. $\frac{2^2}{3} = \frac{(2)(2)}{3} = \frac{4}{3}$

10. $\left[-\frac{2}{3}\right]^2 = \left(-\frac{2}{3}\right)\left(-\frac{2}{3}\right) = \frac{4}{9}$

11. $\frac{-2^2}{3} = \frac{-(2)(2)}{3} = -\frac{4}{3}$

12. $\left[\frac{2}{3}\right]^{-2} = \frac{2^{-2}}{3^{-2}} = \frac{3^2}{2^2} = \frac{9}{4}$

13. $\frac{2}{3}^{-2} = 2^{-2} \cdot \frac{1}{3} = \frac{1}{2^2} \cdot \frac{1}{3} = \frac{1}{4} \cdot \frac{1}{3} = \frac{1}{12}$

14. $\left[\frac{3}{5}\right]^{-3} = \frac{3^{-3}}{5^{-3}} = \frac{5^3}{3^3} = \frac{125}{27}$

15. $(3.5)^{-1} = \frac{1}{3.5}$

16. $8^0 = 1$

17. $x^0 = 1$

18. $(5.3)^0 = 1$

19. $(-6.5)^2 = (-6.5)(-6.5) = 42.25$

20. $-6.5^2 = -(6.5)(6.5) = -42.25$

D. Write each in expanded exponential form.

1. $356.52 = [3 \times 10^2] + [5 \times 10^1] + [6 \times 10^0] + [5 \times 10^{-1}] + [2 \times 10^{-2}]$

2. $5.00030 = [5 \times 10^0] + [3 \times 10^{-4}]$

3. $130004.006 = [1 \times 10^5] + [3 \times 10^4] + [4 \times 10^0] + [6 \times 10^{-3}]$

4. $0.003400 = [3 \times 10^{-3}] + [4 \times 10^{-4}]$

5. $706.5 = [7 \times 10^2] + [6 \times 10^0] + [5 \times 10^{-1}]$

E. Write the standard numeral for each of the following.

1. $[5 \times 10^2] + [6 \times 10^1] + [4 \times 10^0] + [7 \times 10^{-1}] = 500 + 60 + 4 + 0.7 = 564.7$

2. $[5 \times 10^4] + [3 \times 10^0] + [6 \times 10^{-1}] = 50000 + 3 + 0.6 = 50003.6$

3. $[4 \times 10^3] + [6 \times 10^{-1}] + [7 \times 10^{-2}] + [8 \times 10^{-3}] = 4000 + 0.6 + 0.07 + 0.008 = 4000.678$

4. $[3 \times 10^2] + [6 \times 10^1] + [0 \times 10^0] + [6 \times 10^{-1}] = 300 + 60 + 0 + 0.6 = 360.6$

5. $[9 \times 10^5] + [6 \times 10^4] + [3 \times 10^{-3}] = 900000 + 60000 + 0.003 = 960000.003$

9.2 MULTIPLICATION USING EXPONENTS

Multiplication with exponents can be done using the **PRODUCT PROPERTY RULE**. This rule tells us to **add** the exponents when multiplying numbers or letters that have the same base and keep the base the same. $[x^a \cdot x^b = x^{a+b}]$

EXAMPLES:

1. $5^3 \times 5^4 = 5^{3+4} = 5^7$
2. $y^7 \cdot y^5 \cdot y^3 = y^{7+5+3} = y^{15}$
3. $(4x^2)^3 \cdot (4x^2)^6 = (4x^2)^{3+6} = (4x^2)^9$
4. $x^5 \cdot y^3 = x^5 \cdot y^3$ or $x^5 y^3$ (The bases are different so we can't add exponents.)
5. $(5x^3)(5x^4) = 5^1 \cdot x^3 \cdot 5^1 \cdot x^4 = 5^{1+1} \cdot x^{3+4} = 5^2 x^7$

A. Perform the following multiplications using the Product Property Rule outlined above and leave all your answers in exponential form.

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| 1. $6^3 \times 6^2 = 6^5$ | 2. $5^3 \times 5^4 = 5^7$ | 3. $(0.2)^3 \times (0.2)^4 = (0.2)^7$ |
| 4. $(x^3)(x^2)(x^3) = x^8$ | 5. $(7x)^3 (7x)^4 = (7x)^7$ | 6. $(x^2y)^4 \cdot (x^2y)^5 = (x^2y)^9$ |
| 7. $(-3)^4 (-3)^5 = (-3)^9$ | 8. $(9^2)(9^3)(9^5) = 9^{10}$ | 9. $(2x^3)^3 (2x^3)^1 (2x^3)^4 = (2x^3)^8$ |
| 10. $(y^{-8})(y^{-4}) = y^{-12}$ | 11. $(z)^{-3} (z)^{-4} (z)^7 = z^0 = 1$ | 12. $(\frac{2}{3})^3 (\frac{2}{3})^2 (\frac{2}{3})^1 = (\frac{2}{3})^6$ |
| 13. $(m)(m^{-4}) = m^{-3}$ | 14. $(x^{-5})(x^{-3})(x^{-4}) = x^{-12}$ | 15. $(5a^5)^5 (5a^5)^0 = (5a^5)^5$ |
| 16. $(a)(a)(a)(a^0) = a^3$ | 17. $(m^{-2})(m^{-3}) = m^{-5}$ | 18. $(p^2)(p^3)(p^2) = p^7$ |
| 19. $(3x^2y)^5 (3x^2y)^7 = (3x^2y)^{12}$ | 20. $(-z)^3 (z)^2 = z^5$
$(-1 \cdot z)^3 (z)^2 = -1z^5$ | 21. $4^7 \cdot 4^8 \cdot 4^{-2} = 4^{13}$ |

B. Extra Practice. Perform the following multiplications using the Product Property Rule and leave your answers in exponential form.

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|--|---|---|
| 1. $(8)(8^2) = 8^3$ | 2. $(x^6)(x^6)(x^5) = x^{17}$ | 3. $(y^3)(x^2)(a^2) = a^2 x^2 y^3$ |
| 4. $(5y^3)(y^2)(5y^4) = 25y^9$ | 5. $(p^{-2})(p^3)(p^0) = p^1$ or p | 6. $(y^3)(x^3)(y^2)(x^4) = x^7 y^5$ |
| 7. $(2^3) \cdot (x^{-3}) \cdot (2^4) \cdot (x^8) = 2^7 x^5$ | 8. $(-5y)^5 (-5y)^{-5} = (-5y)^0 = 1$ | 9. $x^3 y^2 x^2 y^3 = x^5 y^5$ |
| 10. $2x^3 \cdot 2x^4 = 4x^7$ | 11. $3x^2 \cdot 3x^3 \cdot 3x^4 = 3^3 x^9$ | 12. $(8xy^3) (7y^{-4}) = 56xy^{-1} = \frac{56x}{y}$ |
| 13. $(xyz)(x^2y^2z^3) = x^3 y^3 z^4$ | 14. $(\frac{1}{2})^2 (\frac{1}{3})^2 (\frac{1}{2})^3 = (\frac{1}{2})^8$ | 15. $a^2 b^2 c^3 b^3 = a^2 b^5 c^3$ |
| 16. $(-6)^3 (-6)^2 x^2 = (-6)^5 x^2$ | 17. $y^3 y^{-3} y^4 y^{-7} = y^{-3} = \frac{1}{y^3}$ | 18. $(3.1)^4 (3.1)^{-3} = (3.1)^1 = 3.1$ |
| 19. $g^{-6} \cdot g^4 \cdot g^{-4} = g^{-6}$
or $\frac{1}{g^6}$ | 20. $3^a \cdot 3^a \cdot 3^a = (3^a)^3 = 3^{3a}$ | 21. $x^a \cdot x^b \cdot x^c \cdot x^d = x^{a+b+c+d}$ |