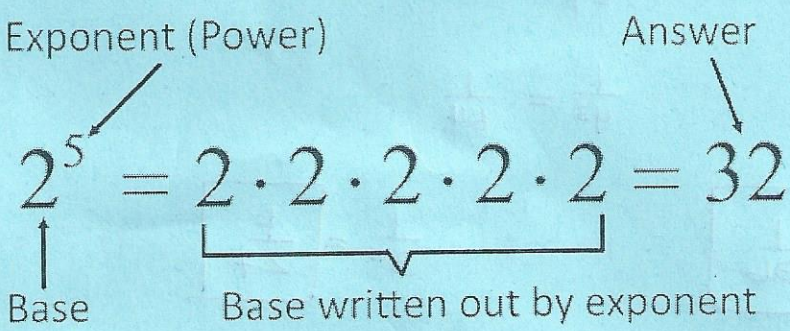
EMA
Exponential Rules

Name KEY
Date _____ Period _____

Exponents



Practice

1. $5^3 =$ 125
2. $-5^3 =$ -125
3. $(-5)^3 =$ -125
4. $(-5)^4 =$ 625
5. $-6^2 =$ -36
6. $(-2)^3 - 2^3 =$ -16
   -8 -8

Power of One and Zero as an Exponent

$4^3 =$ 64

$4^2 =$ 16

$4^1 =$ 4

$4^0 =$ 1

FORMULAS

Therefore.... $a^0 = 1$ and $a^1 = a$

Practice

7. $16^0 =$ 1
8. $19{,}525^1 =$ 19,525
9. $37^1 =$ 37
10. $111^0 =$ 1
11. $-2^1 =$ -2
12. $-2^0 =$ -1
13. $305^0 + 120^1 =$ 121
    1 + 120
14. $(-2)^1 + (-2)^0 =$ -1
    -2 + 1

Negative Exponents

***Can NEVER, EVER have a negative exponent.

FORMULA

$a^{-n} = \frac{1}{a^n}$

$4^3 = 64$

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

Practice

15. $6^{-2} = \frac{1}{6^2} = \boxed{\frac{1}{36}}$

16. $3^{-3} = \frac{1}{3^3} = \boxed{\frac{1}{27}}$

17. $5^{-3} = \frac{1}{5^3} = \boxed{\frac{1}{125}}$

18. $5^{-1} = \boxed{\frac{1}{5}}$

19. $-2^3 = \boxed{-8}$

20. $(-3)^{-4} = \frac{1}{(-3)^4} = \boxed{\frac{1}{81}}$

21. $x^{-2} = \boxed{\frac{1}{x^2}}$

22. $xy^{-4} = \boxed{\frac{x}{y^4}}$

23. $x^{-3}y^{-2} = \boxed{\frac{1}{x^3y^2}}$

FORMULA

$\frac{1}{a^{-n}} = a^n$

24. $\frac{1}{7^{-2}} = 7^2 = \boxed{49}$

25. $\frac{1}{3^{-2}} = 3^2 = \boxed{9}$

26. $\frac{1}{8^{-3}} = 8^3 = \boxed{512}$

27. $\frac{1}{x^{-3}y} = \boxed{\frac{x^3}{y}}$

28. $\frac{1}{x^{-2}y^{-4}} = \boxed{x^2y^4}$

29. $\frac{4}{2^{-3}} = 4 \cdot 2^3 = \boxed{32}$

30. $\frac{7}{3^{-2}xy^{-3}} = \frac{7 \cdot 3^2y^3}{x} = \boxed{\frac{63y^3}{x}}$

31. $\frac{2x}{5^{-2}2^{-2}y} = \frac{2x \cdot 5^2 \cdot 2^2}{y} = \boxed{\frac{200x}{y}}$

32. $\frac{312^0 4^{-2}}{12^{-1}} = \frac{1 \cdot 12^1}{4^2} = \frac{12}{16} = \boxed{\frac{3}{4}}$

Multiplying Powers With Same Base

FORMULA

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

33. $5^3 \cdot 5^6$

$= 5^{3+6}$

$= 5^9$

$= \boxed{1{,}953{,}125}$

34. $2^4 \cdot 2^{-3}$

$= 2^{4+(-3)}$

$= 2^1$

$= \boxed{2}$

35. $7^{-3} \cdot 7^2 \cdot 7^6$

$= 7^{-3+2+6}$

$= 7^5$

$= \boxed{16{,}807}$

36. $x \cdot x^5$

$= x^{1+5}$

$= \boxed{x^6}$

37. $x^2 \cdot x^3 \cdot 7x$

$= 7x^{2+3+1}$

$= \boxed{7x^6}$

38. $6y^2 \cdot 3y^3 \cdot 2y^{-4}$

$= (6 \cdot 3 \cdot 2) y^{2+3+(-4)}$

$= \boxed{36y}$

39. $5x^5 \cdot 3x^2 \cdot 3y^6$

$= (5 \cdot 3 \cdot 3) x^{5+2} y^6$

$= \boxed{45x^7y^6}$

40. $2y^3 \cdot 7x^2 \cdot 2y^4$

$= (2 \cdot 7 \cdot 2) x^2 y^{3+4}$

$= \boxed{28x^2y^7}$

41. $m^2 \cdot n^{-2} \cdot 7m$

$= 7m^{2+1} n^{-2}$

$= 7m^3 n^{-2}$

$= \boxed{\frac{7m^3}{n^2}}$

Power of a Power

FORMULA

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

42. $(5^4)^2 = 5^{4(2)}$

$= 5^8$

$= \boxed{390{,}625}$

43. $(2^7)^4 = 2^{7(4)}$

$= 2^{28}$

$= \boxed{268{,}435{,}456}$

44. $(x^{30})^{10} = x^{30(10)}$

$= \boxed{x^{300}}$

45. $(x^4)^3 \cdot x^5$

$= x^{4(3)} \cdot x^5$

$= x^{12} \cdot x^5$

$= x^{12+5}$

$= \boxed{x^{17}}$

46. $x^3(x^2)^5$

$= x^3 \cdot x^{2(5)}$

$= x^3 \cdot x^{10}$

$= x^{3+10}$

$= \boxed{x^{13}}$

47. $(x^4)^2 \cdot (x^5)^3$

$= x^{4(2)} \cdot x^{5(3)}$

$= x^8 \cdot x^{15}$

$= x^{8+15}$

$= \boxed{x^{23}}$

48. $(x^3)^{-2} \cdot x^9$

$= x^{3(-2)} \cdot x^9$

$= x^{-6} \cdot x^9$

$= x^{-6+9}$

$= \boxed{x^3}$

49. $x^2(x^7)^{-2}$

$= x^2 \cdot x^{7(-2)}$

$= x^2 \cdot x^{-14}$

$= x^{2+(-14)}$

$= x^{-12}$

$= \boxed{\frac{1}{x^{12}}}$

50. $(x^{-3})^4 \cdot (x^2)^{-3}$

$= x^{-3(4)} \cdot x^{2(-3)}$

$= x^{-12} \cdot x^{-6}$

$= x^{-12+(-6)}$

$= x^{-18}$

$= \boxed{\frac{1}{x^{18}}}$

Raising a Product to a Power

FORMULA

$$(ab)^n = a^n b^n$$

51. $(3x)^2$

$= 3^2 x^2$

$= 9x^2$

52. $(2y)^3$

$= 2^3 y^3$

$= 8y^3$

53. $(5x^2)^2$

$= 5^2 x^{2(2)}$

$= 25x^4$

54. $(4g^5)^{-2}$

$= 4^{-2} g^{5(-2)}$

$= \frac{1}{4^2} g^{-10}$

$= \frac{1}{16g^{10}}$

55. $(x^2)^3 \cdot (2x^5)^4$

$= x^{2(3)} \cdot 2^4 x^{5(4)}$

$= x^6 \cdot 16x^{20}$

$= 16x^{6+20}$

$= 16x^{26}$

56. $(2x^3)^2 (3xy^2)^3$

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

$= 4x^6 \cdot 27x^3 y^6$

$= (4 \cdot 27) x^{6+3} y^6$

$= 108x^9 y^6$

57. $(4xy)^2 (3x^{-3})^3$

$= 4^2 x^2 y^2 \cdot 3^3 x^{-3(3)}$

$= 16x^2 y^2 \cdot 27x^{-9}$

$= (16 \cdot 27) x^{2+(-9)} y^2$

$= 432x^{-7} y^2 = \frac{432y^2}{x^7}$

58. $(3 \times 10^5)^2$

$= 3^2 \times 10^{5(2)}$

$= 9 \times 10^{10}$

59. $(2 \times 10^{10})^4$

$= 2^4 \times 10^{10(4)}$

$= 16 \times 10^{40}$

$= 1.6 \times 10^{41}$

Dividing Exponents with Same Base

FORMULA

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

60. $\frac{6^6}{6^4} = 6^{6-4}$

$= 6^2$

$= 36$

61. $\frac{x^5}{x^2} = x^{5-2}$

$= x^3$

62. $\frac{12y^2}{4xy} = \frac{3y}{x}$

63. $-\frac{24xy^{-3}}{8x^2y^3}$

$= -3x^{-1}y^{-6}$

$= \frac{-3}{xy^6}$

64. $\frac{25m^3n^4p^5}{100n^{-2}p^8}$

$= \frac{1}{4} m^3 n^6 p^{-3}$

$= \frac{m^3 n^6}{4p^3}$

65. $\frac{3^4 x^{-2} y^4 z^{-6}}{27x^{-4} y^4 z^4}$

$= \frac{81x^2 y^0 z^{-10}}{27}$

$= \frac{3x^2}{z^{10}}$

Raising a Quotient to a Power

FORMULA

$$\left(\frac{a^m}{b^m}\right)^n = \frac{a^{mn}}{b^{mn}}$$

66. $\left(\frac{3^2}{4^3}\right)^2$

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

$= \frac{3^4}{4^6}$

$= \boxed{\frac{81}{4096}}$

67. $\left(\frac{x^5}{y^4}\right)^4$

$= \frac{x^{5(4)}}{y^{4(4)}}$

$= \boxed{\frac{x^{20}}{y^{16}}}$

68. $\left(\frac{2x^3y^2}{3xy^4}\right)^3$

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

$= \frac{8x^9y^6}{27x^3y^{12}}$

$= \boxed{\frac{8x^6}{27y^6}}$

69. $\left(\frac{4x^2y^{-3}}{3xy^7}\right)^2$

$= \frac{4^2 x^{2(2)} y^{-3(2)}}{3^2 x^2 y^{7(2)}}$

$= \frac{16x^4y^{-6}}{9x^2y^{14}}$

$= \boxed{\frac{16x^2}{9y^{20}}}$

70.) $\left(\frac{-3m^{-2}}{5n^{-4}}\right)^{-2}$

$= \frac{(-3)^{-2} m^{-2(-2)}}{5^{-2} n^{-4(-2)}}$

$= \boxed{\frac{25m^4}{9n^8}}$

71.) $\left(\frac{-4x^3y^{-2}}{5x^{-2}y^{-6}}\right)^{-3}$

$= \frac{(-4)^{-3} x^{3(-3)} y^{-2(-3)}}{5^{-3} x^{-2(-3)} y^{-6(-3)}}$

$= \frac{125\ x^{-9}\ y^6}{64\ x^6\ y^{18}}$

$= \frac{125}{64} x^{-9-6} y^{6-18}$

$= \frac{125}{64} x^{-15} y^{-12}$

$= \boxed{\frac{125}{64x^{15}y^{12}}}$

Exponent Rules - Recap

$a^0 = 1$

$\frac{1}{a^{-1}} = a$

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

$(a^m b^m)^n = a^{m(n)} b^{m(n)}$

$\left(\frac{a^m}{b^m}\right)^n = \frac{a^{m(n)}}{b^{m(n)}}$

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

$a^{-1} = \frac{1}{a}$

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