Name: Key Date:
Algebra 1 Band:

Unit 6: Exponents and Exponential Functions

LT#1: Simplify expressions involving zero and negative exponents.

Simplify each expression.

1. $5^0 = 1$

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

3. $\frac{4x^{-2}}{y^{-8}}$ $\frac{4y^8}{x^2}$

4. $\frac{1}{p^2q^{-4}r^0}$ $\frac{q^4}{p^2}$

Evaluate each expression for $x = 2, y = -3$, and $z = -5$.

5. $x^0y^2 = y^2$ $(-3)^2 = \boxed{9}$

6. $(-x)^{-4}y^2 = \frac{y^2}{(-x)^4}$ $\frac{(-3)^2}{(-2)^4} = \boxed{\frac{9}{16}}$

7. $x^0z^0 = \boxed{1}$

8. $\frac{5x^0}{y^{-2}} = 5y^2$ $5(-3)^2 = 5(9) = \boxed{45}$

9. $y^{-2}z^2 = \frac{z^2}{y^2}$ $\frac{(-5)^2}{(-3)^2} = \boxed{\frac{25}{9}}$

10. $\frac{2x}{y^2z^{-1}} = \frac{2xz}{y}$ $\frac{2(2)(-5)}{-3} = \frac{-20}{-3} = \boxed{\frac{20}{3}}$

11. Is it true that $(-3b)^4 = -12b^4$? Explain why or why not.

$(-3b)^4 = (-3)^4 b^4 = 81b^4$ because $(-3)^4 = 81$

LT#2: Multiply powers with the same base.

Complete each equation by finding the "?".

12. $3^2 \cdot 3^? = 3^{10}$ $3^2 \cdot 3^8 = 3^{10}$ $2 + \boxed{8} = 10$

13. $a^6 \cdot a^? = a^8$ $a^6 \cdot a^2 = a^8$ $6 + \boxed{2} = 8$

14. $x^2y^5 \cdot x^?y^? = x^5y^{11}$ $x^2y^5 \cdot x^3y^6 = x^5y^{11}$ $2 + \boxed{3} = 5$ $5 + \boxed{6} = 11$

15. $a^{\frac{1}{2}} \cdot a^{?} = a$

$a^{\frac{1}{2}} \cdot a^{\frac{1}{2}} = a^{1}$

$\frac{1}{2} + \boxed{\frac{1}{2}} = 1$

16. $x^{\frac{2}{3}} \cdot x^{?} = x^{\frac{11}{12}}$

$x^{\frac{8}{12}} \cdot x^{\frac{1}{4}} = x^{\frac{11}{12}}$

$\frac{8}{12} + \boxed{\frac{3}{12}} = \frac{11}{12}$

$\boxed{\frac{1}{4}}$

17. $m^{\frac{3}{4}}n^{\frac{1}{2}} \cdot m^{?}n^{?} = m^{\frac{5}{4}}n$

$m^{\frac{3}{4}}n^{\frac{1}{2}} \cdot m^{\frac{1}{2}}n^{\frac{1}{2}} = m^{\frac{5}{4}}n$

Simplify each expression.

18. $2d^2 \cdot d^3$

$2d^{2+3}$

$\boxed{2d^5}$

19. $(x^3)(x^4)$

x^{3+4}

$\boxed{x^7}$

20. $(x^3y^5)(-y^7x^1)$

$-x^{3+1}y^{5+7}$

$\boxed{-x^4y^{12}}$

21. $\left(s^{\frac{3}{5}}\right)\left(s^{\frac{2}{3}}\right)$

$s^{\frac{3}{5}+\frac{2}{3}} = s^{\frac{9}{15}+\frac{10}{15}}$

$\boxed{s^{\frac{19}{15}}}$

22. $\left(p^{\frac{1}{3}}q^{1}\right)\left(q^{\frac{1}{2}}p^{1}\right)$

$p^{\frac{1}{3}+1}\ q^{1+\frac{1}{2}}$

$\boxed{p^{\frac{4}{3}}q^{\frac{3}{2}}}$

23. $2m^{\frac{3}{4}}n^2 \cdot 2m^{\frac{1}{4}}n^{1}$

$4m^{\frac{3}{4}+\frac{1}{4}}n^{2+1}$

$\boxed{4mn^3}$

24. Each square inch of your body has about 6.5×10^2 pores. Suppose the back of your hand has an area of about 0.12×10^2 in^2. About how many pores are on the back of your hand? Write your answer in scientific notation.

$(6.5 \times 10^2)(0.12 \times 10^2) = (6.5 \times 0.12)(10^2 \times 10^2)$

$= 0.78 \times 10^4 = \boxed{7.8 \times 10^3}$ pores

LT#3: Raise a power to a power.
LT#4: Raise a product to a power.

Complete each equation by finding the "?".

25. $(5^5)^{?} = 5^{15}$

$(5^{5})^{\boxed{3}} = 5^{15}$

$5 \cdot 3 = 15$

26. $(b^{-4})^{?} = b^{20}$

$(b^{-4})^{\boxed{-5}} = b^{20}$

$-4 \cdot -5 = 20$

27. $(4x^3y^5)^{?} = 16x^6y^{10}$

$(4x^3y^5)^{\boxed{2}} = 16x^6y^{10}$

28. $\left(x^{\frac{2}{3}}\right)^{?} = x^2$

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

$\frac{2}{3} \cdot 3 = 2$

29. $\left(a^{\frac{1}{2}}\right)^{?} = a^{\frac{1}{4}}$

$\left(a^{\frac{1}{2}}\right)^{\frac{1}{2}} = a^{\frac{1}{4}}$

$\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$

30. $\left(2x^2y^{\frac{1}{4}}\right)^{?} = 4x^4y^{\frac{1}{2}}$

$\left(2x^2y^{\frac{1}{4}}\right)^{2} = 4x^4y^{\frac{1}{2}}$

Simplify each expression.

31. $(q^3r)^4$

$q^{3\cdot4}r^4$

$\boxed{q^{12}r^4}$

32. $(1.34)^2(1.34)^{-8}$

$(1.34)^{2+-8} = (1.34)^{-16}$

$= \boxed{\frac{1}{(1.34)^{16}}}$

33. $(12x^2y^{-2})^5(4xy^{-3})^{-7}$

$12^5x^{10}y^{-10} \cdot 4^{-7}x^{-7}y^{21}$

$\boxed{\frac{12^5}{4^7}x^3y^{11}}$

34. $(-2r^{-4})^2(-3r^2z^8)^{-1}$

$4r^{-8} \cdot -3^{-1}r^{-2}z^{-8}$

$\frac{4}{-3}r^{-10}z^{-8} = \boxed{\frac{4}{-3r^{10}z^8}}$

35. $\left(x^{\frac{4}{7}}\right)^7$

x^4

36. $\left(a^{\frac{3}{4}}b^{\frac{7}{8}}\right)^4$

$a^3b^{\frac{7}{2}}$

LT#5: Divide powers with the same base.

Simplify each expression.

37. $\frac{w^2}{w^5} = w^{-3} = \frac{1}{w^3}$

38. $\frac{21x^3}{3x^{-1}} = 7x^4$

39. $\left(\frac{n^5}{v^3}\right)^7 = \frac{n^{35}}{v^{21}}$

40. $\left(\frac{3c^3}{e^5}\right)^{-4} = \left(\frac{e^5}{3c^3}\right)^4 = \frac{e^{20}}{3^4 c^{12}} = \boxed{\frac{e^{20}}{81c^{12}}}$

Simplify each quotient. Write your answer in scientific notation.

41. $\frac{4.2 \times 10^8}{2.1 \times 10^{11}} = \left(\frac{4.2}{2.1}\right)\left(\frac{10^8}{10^{11}}\right)$

$= \boxed{2 \times 10^{-3}}$

42. $\frac{3.1 \times 10^4}{1.24 \times 10^2} = \left(\frac{3.1}{1.24}\right)\left(\frac{10^4}{10^2}\right)$

$= \boxed{2.5 \times 10^2}$

43. $\frac{4.5 \times 10^3}{9 \times 10^7} = \left(\frac{4.5}{9}\right)\left(\frac{10^3}{10^7}\right)$

$= 0.5 \times 10^{-4}$

$= \boxed{5 \times 10^{-5}}$

44. $\frac{5.1 \times 10^5}{1.7 \times 10^2} = \left(\frac{5.1}{1.7}\right)\left(\frac{10^5}{10^2}\right)$

$= \boxed{3 \times 10^3}$

45. List the steps that you would use to simplify $\left(\frac{5a^8}{10a^6}\right)^{-3}$.

Note: there are other methods that work too.

① Reciprocal the fraction and make the exponent positive

$= \left(\frac{10a^6}{5a^8}\right)^3$

② Simplify the fraction in parentheses

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

③ Distribute the power

$= \frac{2^3}{a^6} = \boxed{\frac{8}{a^6}}$

LT#6: Rewrite expressions involving radicals and rational exponents.

Write each expression in radical form.

46. $m^{\frac{1}{2}}$

$\sqrt{m}$

47. $p^{\frac{2}{3}}r^{\frac{4}{5}}$

$\sqrt[3]{p^2} \cdot \sqrt[5]{r^4}$

48. $(36x^4)^{\frac{1}{2}}$

$36^{\frac{1}{2}} x^2$

$6x^2$

49. $(125x)^{\frac{1}{3}}$

$125^{\frac{1}{3}} x^{\frac{1}{3}}$

$5\sqrt[3]{x}$

50. $(64)^{\frac{1}{2}}x^{\frac{3}{4}}$

$8\sqrt[4]{x^3}$

51. $25^{\frac{1}{3}}(x^2y)^{\frac{1}{2}}$

$\sqrt[3]{25} \cdot x \cdot y^{\frac{1}{2}}$

$x\sqrt[3]{25}\sqrt{y}$

Write each expression as a power with a rational exponent.

52. $\sqrt{xy}$

$(xy)^{\frac{1}{2}} = x^{\frac{1}{2}}y^{\frac{1}{2}}$

53. $\sqrt[4]{a}$

$a^{\frac{1}{4}}$

54. $\sqrt[3]{b^2}$

$b^{\frac{2}{3}}$

55. $\sqrt[3]{x^6y^9}$

$(x^6y^9)^{\frac{1}{3}}$

x^2y^3

56. $\sqrt[4]{81x^2}$

$(81x^2)^{1/4}$

$81^{\frac{1}{4}} x^{\frac{1}{2}}$

$3x^{\frac{1}{2}}$

57. $\sqrt[5]{x^2y^3}$

$(x^2y^3)^{\frac{1}{5}} = x^{\frac{2}{5}}y^{\frac{3}{5}}$

LT#7: Evaluate and graph exponential functions.

Evaluate each function for the domain {1, 2, 3}.

58. $f(x) = 4^x$

domain	range
1	$4^1 = 4$
2	$4^2 = 16$
3	$4^3 = 64$

59. $y = 0.01^x$

domain	range
1	$0.01^1 = 0.01$
2	$0.01^2 = 0.0001$
3	$0.01^3 = 0.000001$

60. $y = 40\left(\frac{1}{2}\right)^x$

domain	range
1	$40(\frac{1}{2})^1 = 20$
2	$40(\frac{1}{2})^2 = 10$
3	$40(\frac{1}{2})^3 = 5$

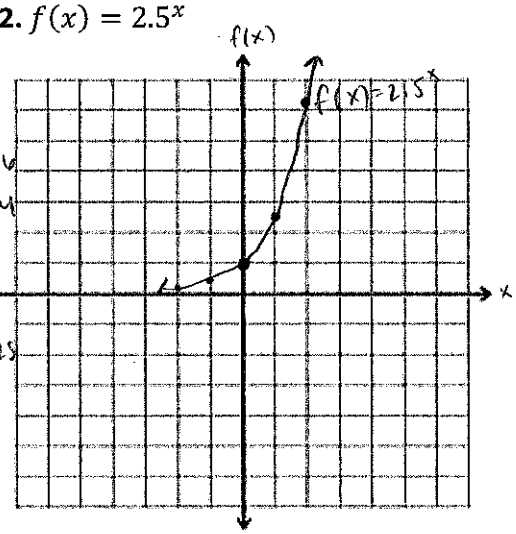
61. $f(x) = 3 \cdot 2^x$

domain	range
1	$3 \cdot 2^1 = 6$
2	$3 \cdot 2^2 = 12$
3	$3 \cdot 2^3 = 24$

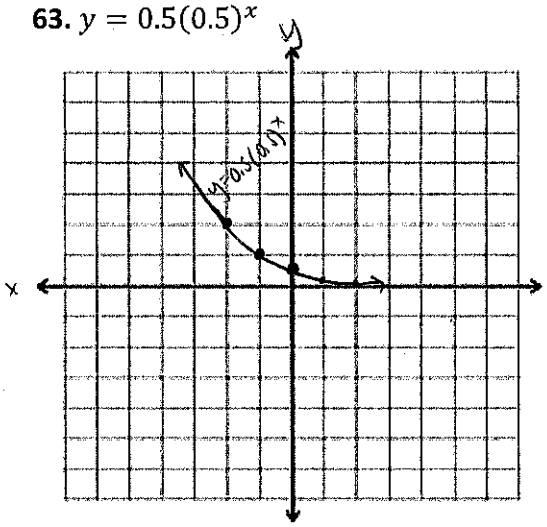
Graph each function.

62. $f(x) = 2.5^x$

x	f(x)
-2	$2.5^{-2} = 0.16$
-1	$2.5^{-1} = 0.4$
0	$2.5^0 = 1$
1	$2.5^1 = 2.5$
2	$2.5^2 = 6.25$



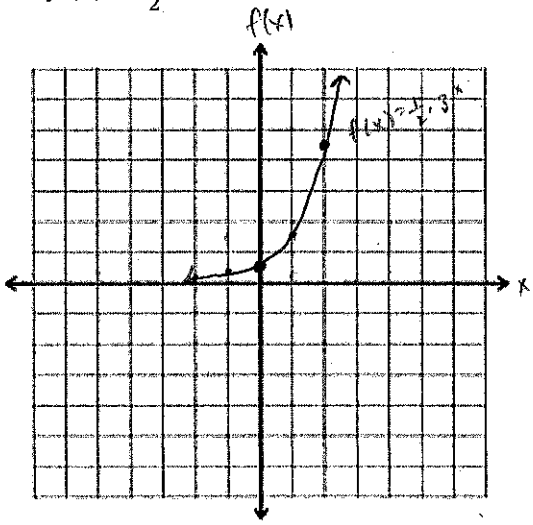
63. $y = 0.5(0.5)^x$



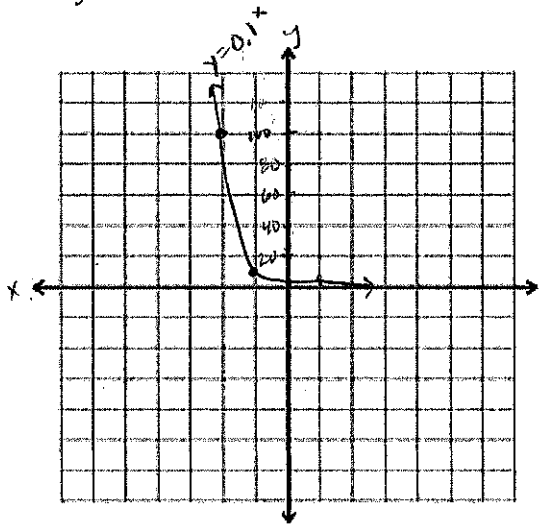
x	y
-2	$0.5(0.5)^{-2} = 2$
-1	$0.5(0.5)^{-1} = 1$
0	$0.5(0.5)^0 = 0.5$
1	$0.5(0.5)^1 = \frac{1}{4}$
2	$0.5(0.5)^2 = \frac{1}{8}$

64. $f(x) = \frac{1}{2} \cdot 3^x$

x	f(x)
-2	$\frac{1}{2} \cdot 3^{-2} = \frac{1}{18}$
-1	$\frac{1}{2} \cdot 3^{-1} = \frac{1}{6}$
0	$\frac{1}{2} \cdot 3^0 = \frac{1}{2}$
1	$\frac{1}{2} \cdot 3^1 = \frac{3}{2}$
2	$\frac{1}{2} \cdot 3^2 = \frac{9}{2}$



65. $y = 0.1^x$



x	y
-2	$0.1^{-2} = 100$
-1	$0.1^{-1} = 10$
0	$0.1^0 = 1$
1	$0.1^1 = 0.1$
2	$0.1^2 = 0.01$

66. A population of 50 bacteria in a laboratory culture doubles every 30 min. The function $p(x) = 50 \cdot 2^x$ models the population, where x is the number of 30-min periods.
A. How many bacterial will there by after 2 h?

2h = 4 30min periods

$p(4) = 50 \cdot 2^4 = 50 \cdot 16 = \boxed{800}$

B. How many bacteria will there by after 1 day?

1 day = 24 hours = 48 30min periods

$p(48) = 50 \cdot 2^{48} = 50 \cdot 2.814749767 \times 10^{14} = \boxed{1.407374884 \times 10^{16}}$

not on test

LT#8: Model exponential growth and decay.

Tell whether the function represents *exponential growth* or *exponential decay*. Identify the growth or decay factor.

67. $y = 5.2 \cdot 3^x$ **68.** $y = 7 \cdot 0.32^x$ **69.** $y = 0.15\left(\frac{3}{2}\right)^x$ **70.** $g(x) = 1/3\left(\frac{1}{4}\right)^x$

growth | decay | growth | decay

growth factor = 3 | decay factor = 0.32 | growth factor = $\frac{3}{2}$ | decay factor = $\frac{1}{4}$

71. Suppose $2000 is deposited in an account paying 2.5% interest compounded quarterly. What will the account balance be after 12 yr?

$x = \frac{12}{4} = 3$ yr

$y = 2000 \cdot 1.025^x$

$y = 2000 \cdot 1.025^3$

$= 2153.78125$

$\approx \boxed{\$2153.78}$

72. A band performs a free concert in a local park. There are 200 people in the crowd at the start of the concert. The number of people in the crowd grows 15% every half hour. How many people are in the crowd after 3 h? Round to the nearest person.

$x = \frac{3}{\frac{1}{2}} = 6$

$y = 200 \cdot 1.15^x$

$y = 200 \cdot 1.15^6$

$= 462.61215 31$

$\approx \boxed{463}$