

Concept and Vocabulary Check:

1. The negative exponent rule states that $b^{-n} = \underline{\hspace{2cm}}$, $b \neq 0$.
4. Negative exponents in denominators can be evaluated using $\frac{1}{b^{-n}} = \underline{\hspace{2cm}}$, $b \neq 0$.
7. A positive number is written in scientific notation when it is expressed in the form $a \times 10^n$, where a is _____ and n is a/an _____.

Practice Exercises:

In exercises 1 - 75, write each expression with positive exponents only. Then simplify, if possible.

1. 8^{-2}

13. $\frac{1}{3^{-2}}$

5. $(-6)^{-2}$

17. $\frac{2^{-3}}{8^{-2}}$

7. -6^{-2}

19. $\left(\frac{1}{4}\right)^{-2}$

9. 4^{-1}

23. $\frac{1}{6x^{-5}}$

11. $2^{-1} + 3^{-1}$

25. $\frac{x^{-8}}{y^{-1}}$

51. $\frac{(6y^4)^3}{y^{-5}}$

29. $x^{-8} \cdot x^3$

55. $\left(\frac{4x^5}{2x^2}\right)^{-4}$

31. $(4x^{-5})(2x^2)$

61. $\frac{2x^5 \cdot 3x^7}{15x^6}$

37. $\frac{30z^5}{10z^{10}}$

63. $(x^3)^5 \cdot x^{-7}$

39. $\frac{-8x^3}{2x^7}$

69. $(y^{10})^{-5}$

41. $\frac{-9a^5}{27a^8}$

71. $(a^4b^5)^{-3}$

45. $\frac{x^3}{(x^4)^2}$

75. $\left(\frac{x^2}{2}\right)^{-2}$

47. $\frac{y^{-3}}{(y^4)^2}$

77. $\left(\frac{x^2}{y^3}\right)^{-3}$

In Exercises 79 - 105, change from scientific to decimal notation or decimal to scientific, as necessary.

79. 8.7×10^2

93. 220,000,000

81. 9.23×10^5

95. 713

83. 3.4×10^0

97. 6751

85. 7.9×10^{-1}

99. 0.0027

87. 2.15×10^{-2}

101. 0.0000202

89. 7.86×10^{-4}

103. 0.005

91. 32,400

105. 3.14159

In exercises 107 - 125, perform the indicated computations, writing your answer in scientific notation.

107. $(2 \times 10^3)(3 \times 10^2)$

117. $\frac{180 \times 10^6}{2 \times 10^3}$

109. $(2 \times 10^5)(8 \times 10^3)$

119. $\frac{3 \times 10^4}{12 \times 10^{-3}}$

111. $\frac{12 \times 10^6}{4 \times 10^2}$

121. $(5 \times 10^2)^3$

113. $\frac{15 \times 10^4}{5 \times 10^{-2}}$

123. $(3 \times 10^{-2})^4$

115. $\frac{15 \times 10^{-4}}{5 \times 10^2}$

125. $(4 \times 10^6)^{-1}$

In exercises 127 and 133, simplify the exponential expression. Assume that variables represent nonzero real numbers.

127. $\frac{(x^{-2}y)^{-3}}{(x^2y^{-1})^3}$

133. $\frac{(2^{-1}x^{-2}y^{-1})^{-2}(2x^{-4}y^3)^{-2}(16x^{-3}y^3)^0}{(2x^{-3}y^{-5})^2}$

Applications:

139. In 2009, the United States government spent more than it had collected in taxes, resulting in a budget deficit of \$1.35 trillion.
- Express 1.35 trillion in scientific notation.
 - Express the 2009 U.S. population, 307 million, in scientific notation.
 - Use your scientific notation answers from parts (a) and (b) to answer the following question: If the 2009 budget deficit was evenly divided among every individual in the United States, how much would each citizen have to pay? Express the answer in scientific and decimal notations.
141. If there are approximately 3.2×10^7 seconds in a year, approximately how many years is 1.35 trillion seconds?
143. Use the formula $d = rt$, distance equals rate times time, and the fact that light travels at the rate of 1.86×10^5 miles per second to answer the following question: If the moon is approximately 2.325×10^5 miles from Earth, how many seconds does it take moonlight to reach Earth?