

**4.6 Negative Exponents and Scientific Notation**

**Solutions**

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| Rewrite each expression using positive exponents only.  |  |
| <p>1. <math>x^{-2}</math></p> $= \frac{1}{x^2}$   | <p>2. <math>a^{-5}</math></p>            |
| <p>3. <math>2^{-3}</math></p> $= \frac{1}{2^3} = \frac{1}{8}$   | <p>4. <math>5^{-2}</math></p>            |
| <p>5. <math>(5x)^{-2}</math></p> $= \frac{1}{(5x)^2} = \frac{1}{25x^2}$   | <p>6. <math>(2a)^{-4}</math></p>         |
| <p>7. <math>5x^{-2}</math></p> $= 5 \cdot \frac{1}{x^2} = \frac{5}{1} \cdot \frac{1}{x^2} = \frac{5}{x^2}$  | <p>8. <math>3y^{-5}</math></p>           |
| Write each of the following as a decimal.   |  |
| <p>9. <math>5^{-1}</math></p> $= \frac{1}{5} = 1 \div 5 = 0.2$  | <p>10. <math>10^{-1}</math></p>          |
| <p>11. <math>5 \times 10^{-1}</math></p> $= 5 \cdot \frac{1}{10} = 5(1 \div 10) = 5 \cdot 0.1 = 0.5$  | <p>12. <math>2 \times 10^{-3}</math></p> |
| <p>13. <math>54 \times 10^2</math></p> $= 54 \cdot 100 = 5,400$   | <p>14. <math>32 \times 10^4</math></p>   |
| <p>Answers: 1. <math>\frac{1}{x^2}</math>; 3. <math>\frac{1}{2^3} = \frac{1}{8}</math>; 5. <math>\frac{1}{25x^2}</math>; 7. <math>\frac{5}{x^2}</math>; 9. 0.2; 11. 0.5 13. 5,400</p> |  |

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| Write each number in scientific notation.   |   |
| <b>15.</b> 7,700,000<br>$= 7.7 \times 10^6$   | <b>16.</b> 186,000  |
| <b>17.</b> 0.0023<br>$= 2.3 \times 10^{-3}$   | <b>18.</b> 0.00048  |
| <b>19.</b> 358<br>$= 3.58 \times 10^2$  | <b>20.</b> 14   |
| <b>21.</b> The average distance from earth to the sun is about 93,000,000 miles. Write this number in scientific notation.<br><br>93,000,000 = $9.3 \times 10^7$                    | <b>22.</b> The diameter of an atom is about 0.0000000001 meters. The diameter of a bacteria is about 0.0000005 meters. Write these numbers in scientific notation.<br><br>0.0000000001 =<br>0.0000005 = |
| Convert the following scientific numbers to standard form.  |   |
| <b>23.</b> $1.45 \times 10^{-7}$<br>$= 0.000000145$   | <b>24.</b> $3.7 \times 10^{-5}$   |
| <b>25.</b> $5.4 \times 10^5$<br>$540,000$   | <b>26.</b> $3.02 \times 10^3$   |
| Answers: <b>15.</b> $7.7 \times 10^6$ ; <b>17.</b> $2.3 \times 10^{-3}$ ; <b>19.</b> $3.58 \times 10^2$ ; <b>21.</b> $9.3 \times 10^7$ ; <b>23.</b> 0.000000145; <b>25.</b> 540,000 |   |

Simplify. Write your final answer using positive exponents only.

27.  $x^5 \cdot x^2$

$$= x^{5+2} = x^7$$

28.  $x^3 \cdot x^{12}$

29.  $x^5 \cdot x^{-2}$

$$= x^{5+(-2)} = x^3$$

30.  $x^7 \cdot x^{-6}$

31.  $x^{-7} \cdot x^{-6}$

$$= x^{-7+(-6)} = x^{-13} = \frac{1}{x^{13}}$$

32.  $x^{-2} \cdot x^{-8}$

33.  $\frac{x^7}{x^3}$

$$= x^{7-3} = x^4$$

34.  $\frac{x^5}{x^2}$

35.  $\frac{x^{-7}}{x^3}$

$$= x^{-7-3} = x^{-10} = \frac{1}{x^{10}}$$

36.  $\frac{x^{-4}}{x^5}$

37.  $\frac{x^{-7}}{x^{-5}}$

$$= x^{-7-(-5)} = x^{-2} = \frac{1}{x^2}$$

38.  $\frac{x^{-10}}{x^{-2}}$

Answers: 27.  $x^7$ ; 29.  $x^3$ ; 31.  $\frac{1}{x^{13}}$ ; 33.  $x^4$ ; 35.  $\frac{1}{x^{10}}$ ; 37.  $\frac{1}{x^2}$

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| Simplify. Write your answers using positive exponents only.  |   |
| <b>39.</b> $(x^{-2})^3$<br>$= x^{-2 \cdot 3} = x^{-6} = \frac{1}{x^6}$   | <b>40.</b> $(x^{-5})^2$                     |
| <b>41.</b> $(x^{-2})^{-5}$<br>$= x^{-2 \cdot -5} = x^{10}$   | <b>42.</b> $(x^{-3})^{-7}$                  |
| <b>43.</b> $(2x^4)(5x^{-3})$<br>$= 2 \cdot 5 \cdot x^4 \cdot x^{-3} = 10x^{4+(-3)} = 10x$  | <b>44.</b> $(4x^5)(8x^{-2})$                |
| <b>45.</b> $(5x^4y^{-1})(4x^{-3}y^{-2})$<br>$= 5 \cdot 4 \cdot x^4 \cdot x^{-3} \cdot y^{-1} \cdot y^{-2} = 20x^{4+(-3)}y^{-1+(-2)}$<br>$= 20xy^{-3} = 20x \cdot \frac{1}{y^3} = \frac{20}{1} \cdot \frac{x}{1} \cdot \frac{1}{y^3} = \frac{20x}{y^3}$                         | <b>46.</b> $(2x^7y^{-2})(7x^{-5}y^{-5})$    |
| <b>47.</b> $\frac{15x^{-7}}{10x^3} = \frac{15}{10} \cdot \frac{x^{-7}}{x^3} = \frac{3}{2} \cdot x^{-7-3} = \frac{3}{2} \cdot x^{-10}$<br>$= \frac{3}{2} \cdot \frac{1}{x^{10}} = \frac{3}{2x^{10}}$  | <b>48.</b> $\frac{12x^{-5}}{16x^4}$         |
| <b>49.</b> $\frac{9x^2y^{-1}}{12x^{-3}y^2} = \frac{9}{12} \cdot \frac{x^2}{x^{-3}} \cdot \frac{y^{-1}}{y^2} = \frac{3}{4} \cdot x^{2-(-3)} \cdot y^{-1-2}$<br>$= \frac{3}{4} \cdot x^5 \cdot y^{-3} = \frac{3}{4} \cdot \frac{x^5}{1} \cdot \frac{1}{y^3} = \frac{3x^5}{4y^3}$ | <b>50.</b> $\frac{8a^4b^{-5}}{12a^{-1}b^8}$ |
| Answers: <b>39.</b> $\frac{1}{x^6}$ ; <b>41.</b> $x^{10}$ ; <b>43.</b> $10x$ ; <b>45.</b> $\frac{20x}{y^3}$ ; <b>45.</b> $\frac{3}{2x^{10}}$ ; <b>49.</b> $\frac{3x^5}{4y^3}$  |   |

Simplify. Write your answers using positive exponents only.

$$51. \left(\frac{x}{3}\right)^{-2} = \left(\frac{3}{x}\right)^2 = \frac{9}{x^2}$$

$$52. \left(\frac{5}{y}\right)^{-3}$$

$$53. \left(\frac{x^{-3}}{5}\right)^{-2} = \left(\frac{1}{5x^3}\right)^{-2} = \left(\frac{5x^3}{1}\right)^2 = 25x^6$$

$$54. \left(\frac{x^{-5}}{2}\right)^{-3}$$

$$55. \frac{(3x^{-4}y)^2}{15x^3y^{-2}} = \frac{9x^{-8}y^2}{15x^3y^{-2}} = \frac{9}{15} \cdot \frac{x^{-8}}{x^3} \cdot \frac{y^2}{y^{-2}}$$

$$= \frac{3}{5} \cdot x^{-8-3} \cdot y^{2-(-2)} = \frac{3}{5} \cdot x^{-11} \cdot y^4$$

$$= \frac{3}{5} \cdot \frac{1}{x^{11}} \cdot \frac{y^4}{1} = \frac{3y^4}{5x^{11}}$$

$$56. \frac{(5x^{-3}y^3)^3}{15x^4y^{-1}}$$

$$57. (2x^{-3}y)(3xy^{-2})^2 = (2x^{-3}y) \cdot 3^2 x^2 y^{-2 \cdot 2}$$

$$= 2x^{-3}y \cdot 9x^2y^{-4} = 18x^{-3+2}y^{1+(-4)} = 18x^{-1}y^{-3}$$

$$= \frac{18}{1} \cdot \frac{1}{x} \cdot \frac{1}{y^3} = \frac{18}{xy^3}$$

$$58. (5x^2y^{-3})(2x^3y^{-3})^2$$

Answers: 51.  $\frac{9}{x^2}$ ; 53.  $25x^6$ ; 55.  $\frac{3y^4}{5x^{11}}$ ; 57.  $\frac{18}{xy^3}$