

Section 5.3 Definitions of b^0 and b^{-n}

Section 5.3 Practice Exercises

1. (a) 1

(b) $\left(\frac{1}{b}\right)^n$ or $\frac{1}{b^n}$

3. $c^7 c^2 = c^{7+2}$
 $= c^9$

5. $\frac{y^9}{y^8} = y^{9-8} = y^1 = y$

$$7. \frac{3^{14}}{3^3 \cdot 3^5} = \frac{3^{14}}{3^8} = 3^6 \text{ or } 729$$

$$9. (7w^7z^2)^4 = 7^4(w^7)^4(z^2)^4 \\ = 7^4w^{28}z^8 \text{ or } 2401w^{28}z^8$$

$$11. (a) d^0 = 1$$

$$(b) \frac{d^3}{d^3} = d^{3-3} = d^0 = 1$$

$$13. p^0 = 1$$

$$15. 5^0 = 1$$

$$17. -4^0 = -(4^0) = -1$$

$$19. (-6)^0 = 1$$

$$21. (8x)^0 = 8^0x^0 = 1$$

$$23. -7x^0 = -7 \cdot 1 = -7$$

$$25. (a) t^{-5} = \frac{1}{t^5}$$

$$(b) \frac{t^3}{t^8} = t^{3-8} = t^{-5} = \frac{1}{t^5}$$

$$27. \left(\frac{2}{7}\right)^{-3} = \left(\frac{7}{2}\right)^3 = \frac{7^3}{8^3} \\ = \frac{343}{8}$$

$$29. \left(-\frac{1}{5}\right)^{-2} = (-5)^2 \\ = 25$$

$$31. a^{-3} = \frac{1}{a^3}$$

$$33. 12^{-1} = \frac{1}{12}$$

$$35. (4b)^{-2} = \frac{1}{(4b)^2} = \frac{1}{16b^2}$$

$$37. 6x^{-2} = 6 \cdot \frac{1}{x^2} = \frac{6}{x^2}$$

$$39. (-8)^{-2} = \frac{1}{(-8)^2} = \frac{1}{64}$$

$$41. -3y^{-4} = -3 \cdot \frac{1}{y^4} = -\frac{3}{y^4}$$

$$43. (-t)^{-3} = \frac{1}{(-t)^3} = -\frac{1}{t^3}$$

$$45. \frac{1}{a^{-5}} = a^5$$

$$47. \text{Subtract } (-6). \frac{x^4}{x^{-6}} = x^{4-(-6)} = x^{10}$$

49. The exponent is only on the variable a .

$$2a^{-3} = a \cdot \frac{1}{a^3} = \frac{2}{a^3}$$

$$51. x^{-8}x^4 = x^{-8+4} = x^{-4} = \frac{1}{x^4}$$

$$53. a^{-8}a^8 = a^{-8+8} = a^0 = 1$$

$$55. y^{17}y^{-13} = y^{17+(-13)} = y^4$$

$$57. (m^{-6}n^9)^3 = (m^{-6})^3(n^9)^3 = m^{-18}n^{27} = \frac{n^{27}}{m^{18}}$$

$$59. (-3j^{-5}k^6)^4 = (-3)^4(j^{-5})^4(k^6)^4 \\ = 81j^{-20}k^{24} \\ = \frac{81k^{24}}{j^{20}}$$

$$61. \frac{p^3}{p^9} = p^{3-9} = p^{-6} = \frac{1}{p^6}$$

$$63. \frac{r^{-5}}{r^{-2}} = r^{-5-(-2)} = r^{-3} = \frac{1}{r^3}$$

$$65. \frac{a^2}{a^{-6}} = a^{2-(-6)} \\ = a^8$$

$$67. \frac{y^{-2}}{y^6} = y^{-2-6} = y^{-8} = \frac{1}{y^8}$$

$$69. \frac{7^3}{7^2 \cdot 7^8} = \frac{7^3}{7^{10}} \\ = 7^{3-10} \\ = 7^{-7} = \frac{1}{7^7}$$

$$71. \frac{a^2a}{a^3} = \frac{a^{2+1}}{a^3} \\ = \frac{a^3}{a^3} = 1$$

$$73. \frac{a^{-1}b^2}{a^3b^8} = a^{-1-3}b^{2-8}$$

$$= a^{-4}b^{-6}$$

$$= \frac{1}{a^4b^6}$$

$$75. \frac{w^{-8}(w^2)^{-5}}{w^3} = \frac{w^{-8}w^{-10}}{w^3}$$

$$= \frac{w^{-18}}{w^3} = w^{-21}$$

$$= \frac{1}{w^{21}}$$

$$77. \frac{3^{-2}}{3} = 3^{-2-1}$$

$$= 3^{-3} = \frac{1}{3^3} = \frac{1}{27}$$

$$79. \left(\frac{p^{-1}q^5}{p^{-6}} \right)^0 = 1$$

$$81. (8x^3y^0)^{-2} = 8^{-2}x^{-6}y^0$$

$$= \frac{1}{8^2} \cdot \frac{1}{x^6} \cdot 1$$

$$= \frac{1}{64x^6}$$

$$83. (-8y^{-12})(2y^{16}z^{-2}) = (-8)(2)y^{-12+16}z^{-2}$$

$$= -16y^4z^{-2}$$

$$= \frac{-16y^4}{z^2}$$

$$85. \frac{-18a^{10}b^6}{108a^{-2}b^6} = \frac{-18}{108}a^{10-(-2)}b^{6-6}$$

$$= -\frac{1}{6}a^{12}b^0$$

$$= -\frac{a^{12}}{6}$$

$$87. \frac{(-4c^{12}d^7)^2}{(5c^{-3}d^{10})^{-1}} = \frac{(-4)^2(c^{12})^2(d^7)^2}{(5)^{-1}(c^{-3})^{-1}(d^{10})^{-1}}$$

$$= \frac{16c^{24}d^{14}}{5^{-1}c^3d^{-10}}$$

$$= 16(5)c^{24-3}d^{14-(-10)}$$

$$= 80c^{21}d^{24}$$

$$89. \frac{(2x^3y^2)^{-3}}{(3x^2y^4)^{-2}} = \frac{(3x^2y^4)^2}{(2x^3y^2)^3}$$

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

$$= \frac{9x^4y^8}{8x^9y^6} = \frac{9}{8}x^{4-9}y^{8-6}$$

$$= \frac{9}{8}x^{-5}y^2$$

$$= \frac{9y^2}{8x^5}$$

$$91. \left(\frac{5cd^{-3}}{10d^5} \right)^{-2} = \left(\frac{1}{2}cd^{-3-5} \right)^{-2}$$

$$= \left(\frac{1}{2} \right)^{-2} c^{-2}(d^{-8})^{-2}$$

$$= 2^2 \cdot \frac{1}{c^2}d^{16} = \frac{4d^{16}}{c^2}$$

$$93. (2xy^3) \left(\frac{9xy}{4x^3y^2} \right) = \frac{18x^2y^4}{4x^3y^2}$$

$$= \frac{18}{4}x^{2-3}y^{4-2}$$

$$= \frac{9}{2}x^{-1}y^2 = \frac{9y^2}{2x}$$

$$95. 5^{-1} + 2^{-2} = \frac{1}{5} + \frac{1}{2^2}$$

$$= \frac{1}{5} + \frac{1}{4}$$

$$= \frac{4}{20} + \frac{5}{20} = \frac{9}{20}$$

$$97. 10^0 - 10^{-1} = 1 - \frac{1}{10} = \frac{10}{10} - \frac{1}{10} = \frac{9}{10}$$

$$99. 2^{-2} + 1^{-2} = \frac{1}{2^2} + \frac{1}{1^2} = \frac{1}{4} + 1 = \frac{5}{4}$$

$$101. 4 \cdot 5^0 - 2 \cdot 3^{-1} = 4 \cdot 1 - 2 \cdot \frac{1}{3}$$

$$= 4 - \frac{2}{3}$$

$$= \frac{12}{3} - \frac{2}{3} = \frac{10}{3}$$

103. Since $\frac{y^4 y^{\square}}{y^{-2}} = y^8$, $4 + \square - (-2) = 8$,
so $\square = 2$.

105. Since $\frac{w^{-9}}{w^{\square}} = w^2$, $-9 - \square = 2$,
so $\square = -11$.

Problem Recognition Exercises

1. $t^3 t^5 = t^{3+5} = t^8$

3. $\frac{y^7}{y^2} = y^{7-2} = y^5$

5. $(r^2 s^4)^2 = (r^2)^2 (s^4)^2$
 $= r^4 s^8$

7. $\frac{w^4}{w^{-2}} = w^{4-(-2)} = w^6$

9. $\frac{y^{-7} x^4}{z^{-3}} = \frac{x^4 z^3}{y^7}$

11. $\frac{x^4 x^{-3}}{x^{-5}} = x^{4-3-(-5)} = x^6$

13. $\frac{t^{-2} t^4}{t^8 t^{-1}} = t^{-2+4-8-(-1)}$
 $= t^{-5} = \frac{1}{t^5}$

15. $\frac{1}{p^{-6} p^{-8} p^{-1}} = \frac{1}{p^{-6+(-8)+(-1)}}$
 $= \frac{1}{p^{-15}} = p^{15}$

17. $\frac{v^9}{v^{11}} = v^{9-11}$
 $= v^{-2}$
 $= \frac{1}{v^2}$

19. $\left(\frac{1}{2}\right)^{-1} + \left(\frac{1}{3}\right)^0 = \left(\frac{2}{1}\right)^1 + 1$
 $= 2 + 1 = 3$

21. $(2^5 b^{-3})^{-3} = 2^{5(-3)} b^{(-3)(-3)}$
 $= 2^{-15} b^9 = \frac{b^9}{2^{15}}$

23. $\left(\frac{3x}{2y}\right)^{-4} = \left(\frac{2y}{3x}\right)^4$
 $= \frac{2^4 y^4}{3^4 x^4}$
 $= \frac{16y^4}{81x^4}$

25. $(3ab^2)(a^2b)^3 = (3ab^2)(a^{2(3)}b^3)$
 $= (3ab^2)(a^6b^3)$
 $= 3aa^6b^2b^3$
 $= 3a^7b^5$

27. $\left(\frac{xy^2}{x^3y}\right)^4 = (x^{1-3}y^{2-1})^4$
 $= (x^{-2}y)^4$
 $= x^{-2(4)}y^4$
 $= x^{-8}y^4 = \frac{y^4}{x^8}$

29. $\frac{(t^{-2})^3}{t^{-4}} = \frac{t^{-6}}{t^{-4}} = t^{-6-(-4)}$
 $= t^{-2}$
 $= \frac{1}{t^2}$

31. $\left(\frac{2w^2x^3}{3y^0}\right)^3 = \frac{2^3 w^{2(3)} x^{3(3)}}{3^3 y^{0(3)}}$
 $= \frac{8w^6x^9}{27y^0}$
 $= \frac{8w^6x^9}{27}$

33. $\frac{q^3 r^{-2}}{s^{-1} t^5} = \frac{q^3 s}{r^2 t^5}$

$$\begin{aligned}
 35. \frac{(y^{-3})^2(y^5)}{(y^{-3})^{-4}} &= \frac{(y^{-6})(y^5)}{y^{12}} \\
 &= \frac{y^{-1}}{y^{12}} \\
 &= y^{-1-12} \\
 &= y^{-13} \\
 &= \frac{1}{y^{13}}
 \end{aligned}$$

$$\begin{aligned}
 37. \left(\frac{-2a^2b^{-3}}{a^{-4}b^{-5}} \right)^{-3} \\
 &= (-2a^{2-(-4)}b^{-3-(-5)})^{-3} \\
 &= (-2a^6b^2)^{-3}
 \end{aligned}$$

$$\begin{aligned}
 &= \frac{1}{(-2a^6b^2)^3} \\
 &= \frac{1}{(-2)^3 a^{6(3)} b^{2(3)}} \\
 &= -\frac{1}{8a^{18}b^6}
 \end{aligned}$$

$$\begin{aligned}
 39. (5h^{-2}k^0)^3(5k^{-2})^{-4} \\
 &= (5^3)(h^{-2})^3(k^0)^3(5^{-4})(k^{-2})^{-4} \\
 &= (5^3)h^{-6}k^0(5^{-4})k^8 \\
 &= 5^{3-4}h^{-6}(1)k^8 \\
 &= 5^{-1}h^{-6}k^8 = \frac{k^8}{5h^6}
 \end{aligned}$$