

**Condense each expression to a single logarithm.**

$$1) \log_8 3 + \frac{\log_8 10}{3} + \frac{\log_8 7}{3}$$

$$\log_8 (3\sqrt[3]{70})$$

$$3) 5 \log_4 c + \frac{\log_4 a}{2}$$

$$\log_4 (c^5 \sqrt{a})$$

$$5) 3 \log x + 6 \log y$$

$$\log (y^6 x^3)$$

$$2) 12 \log_8 x + 6 \log_8 y$$

$$\log_8 (y^6 x^{12})$$

$$4) 2 \log_4 a - 3 \log_4 b \quad \log_4 \frac{a^2}{b^3}$$

$$6) \log_4 a + \log_4 b + 2 \log_4 c$$

$$\log_4 (bac^2)$$

**Expand each logarithm.**

$$7) \log_6 (z^4 \sqrt{x}) \quad 4 \log_6 z + \frac{\log_6 x}{2}$$

$$9) \log \left( \frac{u}{v^6} \right)^3$$

$$3 \log u - 18 \log v$$

$$11) \ln \left( \frac{a^3}{b} \right)^2$$

$$6 \ln a - 2 \ln b$$

$$8) \log_3 (a^3 \cdot b)^6$$

$$18 \log_3 a + 6 \log_3 b$$

$$10) \log (u^4 v^6)$$

$$4 \log u + 6 \log v$$

$$12) \ln (7^3 \sqrt[3]{8})$$

$$3 \ln 7 + \frac{\ln 8}{3}$$

**Rewrite each equation in exponential form.**

$$13) \log_{20} \frac{1}{400} = -2$$

$$20^{-2} = \frac{1}{400}$$

$$15) \log_{12} 144 = 2$$

$$12^2 = 144$$

$$14) \log_x y = -4$$

$$x^{-4} = y$$

$$16) \log_x y = -10$$

$$x^{-10} = y$$

**Rewrite each equation in logarithmic form.**

$$17) b^{15} = a$$

$$\log_b a = 15$$

$$18) 18^2 = 324$$

$$\log_{18} 324 = 2$$

$$19) 81^{\frac{1}{2}} = 9$$

$$\log_{81} 9 = \frac{1}{2}$$

$$20) 11^2 = 121$$

$$\log_{11} 121 = 2$$