

Condense each expression to a single logarithm.

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

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

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

$$4) 2 \log_4 a - 3 \log_4 b$$

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

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

Expand each logarithm.

$$7) \log_6 (z^4 \sqrt{x})$$

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

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

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

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

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

Rewrite each equation in exponential form.

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

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

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

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

Rewrite each equation in logarithmic form.

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

$$18) 18^2 = 324$$

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

$$20) 11^2 = 121$$