$$b^a = c \quad \Leftrightarrow \quad a = \log_b c$$

$$\log_x 1 = 0 \qquad \log_x x = 1 \qquad\qquad \log_n(n)^c = c \qquad\qquad n^{\log_n(a)} = a$$

$$\log_n(x \cdot y) = \log_n x + \log_n y$$

$$\log_n\left(\frac{x}{y}\right) = \log_n x - \log_n y \qquad\qquad \log_n c = \frac{\log (c)}{\log (n)} = \frac{\ln (c)}{\ln (n)}$$

$$\log_n(x)^k = k \cdot \log_n(x)$$

Use the properties of Logarithms to write an expanded form of each expression.

1. $\log_T (5x)$

2. $\log_T\left(\dfrac{x}{5}\right)$

3. $\log_7\left(y^3\right)$

4. $\log_8\left(\sqrt{Z}\right)$

5. $\log\left(x^2 y^4\right)$

6. $\log\left(\sqrt[3]{xy^6}\right)$

7. $\log\left(\dfrac{3x}{y}\right)$

8. $\log\left(\dfrac{M}{6N}\right)$

9. $\log\left(\dfrac{\sqrt{w}\, z}{y^5}\right)$

10. $\log_w\left(\dfrac{3\sqrt[5]{d^2}}{c^4 \sqrt{a}}\right)$

11. $\log_x\left(\sqrt[4]{\dfrac{xy^3}{x+1}}\right) =$

12. $\log_5\left(\dfrac{5^a c}{25d^2}\right)$

13. $\log_y\left(\dfrac{\sqrt[3]{y^2+1}}{5y^2}\right)$

Contract each logarithmic expression to one that has a single logarithm expression.

14. $\log_T (8) + \log_T (y)$

15. $\log_w (P) - \log_w (9)$

16. $R\log_N (3)$

17. $3\log_4 D + 5\log_4 E$

18. $2\log x - 8\log z$

19. $\dfrac{1}{4}\log_2 m + \dfrac{1}{8}\log_2 n$

20. $\log x + \log (x-3) - \log (x+4)$

21. $3\log x + \dfrac{1}{2}\log y - \log z$

22. $4\log (x+1) - 2\log y + \log x$

23. $\dfrac{3}{2}\log x - \dfrac{3}{4}\log y - \dfrac{4}{5}\log z$

24. $\dfrac{1}{2}\left[5\log (2w-5) - 3\log w + \log z\right]$

25. $\dfrac{1}{4}\left[3\ln t - 2(\ln r + \ln w)\right]$