**Express in terms of logarithms of x, y, z, or w.**

1. (a) log4 (xz) (b) log4 (y/x) (c) log4 $\sqrt[3]{z}$

2. loga $\frac{x^{3}w}{y^{2}z^{4}}$ 3. log$\frac{\sqrt{y}}{x^{4}\sqrt[3]{z}}$ 4. ln $\sqrt[4]{\frac{x^{7}}{y^{5}z}}$

**Write the expression as one logarithm.**

5. (a) log3x + log3(5y) (b) log3(2z) - log3x (c) 5 log3y

6. 2 logax + $\frac{1}{3}$loga (x-2) - 5 loga(2x+3) 7. log($x^{3}y^{2})-2$ log x$\sqrt[3]{y}-3$ log $(\frac{x}{y})$

8. ln $y^{3}$ + $\frac{1}{3}$ ln($x^{3}y^{6}$) - 5 ln y 9. 2 ln x - 4 ln($\frac{1}{y}$) - 3 ln (xy)

**Solve the equation.**

10. log6(2x - 3) = log612 - log63 11. 2 log3x = 3 log35

12. logx - log(x+1) = 3 log4 13. ln(-4 - x) + ln 3 = ln (2 - x)

14. log2(x+7) + log2x = 3 15. log3(x + 3) + log3(x+5) = 1

16. log3(x - 2) + log3(x - 4) = 2 17. log(x + 3) = 1 - log(x - 2)

18. When the volume control on a stereo system is increased, the voltage across a loudspeaker changes from V1 to V2, and the decibel increase in gain is given by db = 20 log $\frac{V\_{2}}{V\_{1}}$. Find the decibel increase if the voltage changes from 2 volts to 4.5 volts.

19. Pareto's law for capitalist countries states that the relationship between annual income x and the number y of individuals whose income exceeds x is log y = log b - k log x, where b and k are positive constants. Solve this equation for y.

**Sketch the graph of f.**

20. f(x) = log3 (3x) 21. f(x) = 3 log3x

 