1. Evaluate the following logarithms using the definition of logarithm:
   (a) $\log_2(32)$
   (b) $\log_3\left(\frac{1}{9}\right)$
   (c) $\log_{10}(.0001)$
   (d) $\log_{\frac{1}{7}}(49)$
2. Estimate the following logarithms (i.e. find which two consecutive integers the logarithm is in between):
   (a) $\log_{10}(879)$
   (b) $\log_2(12)$
   (c) $\log_5(112)$
   (d) $\log_{10}\left(\frac{1}{3}\right)$
3. Expand each expression as a sum of logarithms:
   (a) $\log_3(27m^4n^2)$
   (b) $\log_2\left(\frac{16a^4}{b}\right)$
   (c) $\log_5(\sqrt{5d^3})$

4. Take each expression and rewrite as one logarithm (evaluate the logarithm if you can)
   (a) $\log_{10} 2 + \log_{10} 50$
   (b) $3 \log_2 x - 5 \log_2 y^4 + 2$
   (c) $3 \log_b 4 + 5 \log_b c - \frac{1}{3} \log_b d^3 - 1$

5. Use logarithms to solve for x
   Ex. $5^x = 25 \Rightarrow x = \log_5 25 = 2$
   (a) $3(7^x) = 1029$
   (b) $1024 \left(\frac{1}{2}\right)^{\frac{x}{25}} = 256$
   (c) $4(3^{2x}) = 36$

6. Solve each logarithmic expression using exponentials
   (a) $\log_2 x = 2$
   (b) $\log_{10}(5x) = 4$
   (c) $\log_{\frac{1}{2}} \left(\frac{x}{8}\right) = 3$

7. Convert the following exponential expressions to expressions in base 2:
   (a) 3^x
   (b) 10^{2x}
   (c) $\left(\frac{1}{5}\right)^x$

8. Find the half-life for the following exponential decay functions
   (a) $y = 4 \left(\frac{1}{3}\right)^x$
   (b) $y = 5 \left(\frac{2}{5}\right)^x$
   (c) $y = (.02)^x$

9. A town grows 10% every year. How many years will it take the town to double in size?