

Directions: For each of the following, write an equivalent expression using a single logarithm.

1. $\log_3 4 \square \log_3 z$

2. $\ln x - \ln w$

3. $\log_{10} 3 - \log_{10} x - \log_{10} 5$

4. $\log_4 6 \square 3 \log_4 x$

5. $5 \ln x \square 2 \ln y - \ln w$

6. $x \log 2 - 3 \log x - \frac{1}{2} \log y$

7. Which of the following expressions is equivalent to $\log_5 \left(\frac{3y^4}{z^2} \right)$, where y and z are positive constants?

(A) $\log_5 3 \square \log_5 [4y] - \log_5 [2z]$

(B) $3 \square 4 \log_5 y - 2 \log_5 z$

(C) $\log_5 3 \square 4 \log_5 y - 2 \log_5 z$

(D) $\frac{\log_5 3 \cdot \log_5 y^4}{\log_5 z^2}$

8. Which of the following expressions is equivalent to $\ln \left(\frac{5e^2}{\sqrt{x}} \right)$, where x is a positive constant?

(A) $2 \square \ln 5 - \frac{1}{2} \ln x$

(B) $2 \ln 5 - \frac{1}{2} \ln x$

(C) $2 \square \ln 5 - 2 \ln x$

(D) $2 \ln 5 - 2 \ln x$

9. Which of the following is equivalent to $3 \log x - 2 \log y \square \frac{1}{2} \log 16$, where x and y are positive constants?

(A) $\log \left(\frac{x^3 \square 4}{y^2} \right)$

(B) $\log \left(\frac{x^3}{4y^2} \right)$

(C) $\log \left(\frac{4x^3}{y^2} \right)$

(D) $\log \left(\frac{8x^3}{y^2} \right)$

10. Which of the following expressions is equivalent to $\log_5 x$, where x is a positive constant?

- (A) $5 \log x$ (B) $\frac{\log 5}{\log x}$ (C) $\frac{\log x}{\log 5}$ (D) $\log x - \log 5$

11. Which of the following expressions is equivalent to $\log_3 7$?

- (A) $\ln 7 - \ln 3$ (B) $\frac{\log_7 10}{\log_3 10}$ (C) $\frac{\log_{10} 3}{\log_3 7}$ (D) $\frac{\ln 7}{\ln 3}$

12. Let $f(x) = \log_6 x$. Which of the following is equivalent to $f(w) - 3 \cdot f(z)$, where w and z are positive constants?

- (A) $\log_6 [w - z^3]$ (B) $\log_6 \left(\frac{w}{z^3} \right)$ (C) $\log_6 \left(\frac{w}{z} \right)^3$ (D) $\log_6 \left(\frac{w}{3z} \right)$ (E) $\log_6 [wz^3]$

13. Let $f(x) = \log|x|$ and let $g(x) = \log|4x|$. Which of the following statements about the graphs of f and g is correct?

- (A) The graph of g is a horizontal translation of the graph of f by -4 units.
(B) The graph of g is a horizontal dilation of the graph of f by a factor of $\frac{1}{4}$.
(C) The graph of g is a vertical translation of the graph of f by 4 units.
(D) The graph of g is a vertical dilation of the graph of f by a factor of 4 .

14. Let $h(x) = \ln|x|$ and let $k(x) = \ln|8x|$. Which of the following statements about the graphs of h and k is correct?

- (A) The graph of k is a horizontal dilation of the graph of h by a factor of 8 .
(B) The graph of h is a horizontal dilation of the graph of k by a factor of 8 .
(C) The graph of k is a vertical translation of the graph of h by -8 units.
(D) The graph of h is a vertical translation of the graph of k by -8 units.