

1. Without using a calculator, find each of:

- (1) $\log_{15} 15^{20}$
- (2) $\log_2 1$
- (3) $\log_5 \frac{1}{125}$
- (4) $\log_{10} 10000$
- (5) $\log_{10} \frac{1}{10}$
- (6) $\ln e^{-19}$
- (7) $\ln \frac{1}{e^{19}}$
- (8) $\log_{16} 4$

2. Without using a calculator, find each of:

- (1) $\log_{17} 17^{10}$
- (2) $\log_3 3$
- (3) $\log_2 \frac{1}{2}$
- (4) $\log_{10} 1$
- (5) $\log_{10} \frac{1}{10}$
- (6) $\ln e^{-14}$
- (7) $\ln \frac{1}{e^{13}}$
- (8) $\log_8 2$

3. Without using a calculator, find each of:

- (1) $\log_{19} 19^{16}$
- (2) $\log_5 5$
- (3) $\log_4 \frac{1}{4}$
- (4) $\log_{10} 100$
- (5) $\log_{10} \frac{1}{1000}$
- (6) $\ln e$
- (7) $\ln \frac{1}{e}$
- (8) $\log_{125} 5$