1. Use properties of logarithms to find the exact value of the expression. Do not use a calculator.

$$\log_7 7^{66}$$

$$\cdot \log_a a^r = r \quad \leftarrow \text{formula}$$

$$\log_7 7^{66} = \boxed{66}$$

2. Use properties of logarithms to find the exact value of the expression. Do not use a calculator.

$$\text{Ln } e^{20}$$

$$\text{Ln } e^a = a \quad \leftarrow \text{formula}$$

$$\text{Ln } e^{20} = \boxed{20}$$

* the Ln e cancels out, so left with the number

3. Use properties of logarithms to find the exact value of the expression. Do not use a calculator.

$$2^{\log_2 3}$$

$$a^{\log_a m} = m \quad \leftarrow \text{formula}$$

$$2^{\log_2 3} = \boxed{3}$$

4. Evaluate.

$$e^{\ln 13}$$

$$e^{\ln a} = a \quad \leftarrow \text{formula}$$

$$e^{\ln 13} = \boxed{13}$$

* the $e^{\ln}$ cancels out, so left with 13

5. Use the quotient rule to expand the logarithmic expression. Whoever possible, evaluate logarithmic expression.

$$\ln \left(\frac{e^9}{r} \right)$$

$$\ln e^9 - \ln r$$

$$\boxed{9 - \ln r}$$

* Since it is a fraction, you will subtract the bottom from the top

* if have "ln e" then it cancels out.

6. Write the expression as a sum and/or difference of logarithms. Express powers as factors.

$$\log_5 \left(\frac{x^{10}}{x-6} \right)$$

$$\log_5 x^{10} - \log_5 (x-6)$$

$$\boxed{10 \log_5 x - \log_5 (x-6)}$$

* Since its a fraction, you subtract the bottom from the top.

* exponents then move infront on "Log"

7. Write the expression as a sum and/or difference of logarithms. Express powers as factors.

$$\log_d (u^9 v^4)$$

$$\log_a (mN) = \log_a m + \log_a N_a \quad \leftarrow \text{formula}$$

$$\log_d (u^9 v^4) = \log_d u^9 + \log_d v^4$$

$$\boxed{9 \log_d u + 4 \log_d v}$$

* if there is an exponent, move it in front of the log.

8. Write the expression as a single logarithm.

* this is working backwards from above.

$$6 \log_7 u + 3 \log_7 v$$

$$\log_7 u^6 + \log_7 v^3 \quad \leftarrow \text{* move number in front of log to be the exponent}$$

$$\log_a m + \log_a N = \log_a (mN) \quad \leftarrow \text{formula}$$

$$\log_7 u^6 + \log_7 v^3 = \boxed{\log_7 (u^6 v^3)}$$

* Since bases are the same we can combine them.
* Since its (+) we put them together with multiplication.

9. Use the change-of-base formula and a calculator to evaluate the logarithm.

$$\log_2 14$$

$$\log_a b = \frac{\log(b)}{\log(a)} \quad \leftarrow \text{Change of base formula}$$

$$\log_2 14 = \frac{\log(14)}{\log(2)} = \boxed{3.807}$$

← type into calculator

✳ To type into calculator:
1. Press fraction button.
2. Press log button, then the number, then close parenthesis.
3. Go down
4. Press log button, then type in number, then close parenthesis.
5. Press enter.

10. Use the change-of-base formula and a calculator to evaluate the logarithm.

$$\log_{1/5} 7$$

$$\log_a b = \frac{\log(b)}{\log(a)} \quad \leftarrow \text{Change of base formula}$$

$$\log_{1/5} 7 = \frac{\log(7)}{\log(\frac{1}{5})} = \boxed{-1.209}$$

← type into calculator

✳ To type into calculator:
1. Press fraction button.
2. Press log button, then the number, then close parenthesis.
3. Go down
4. Press log button, then type in number, then close parenthesis.
5. Press enter.