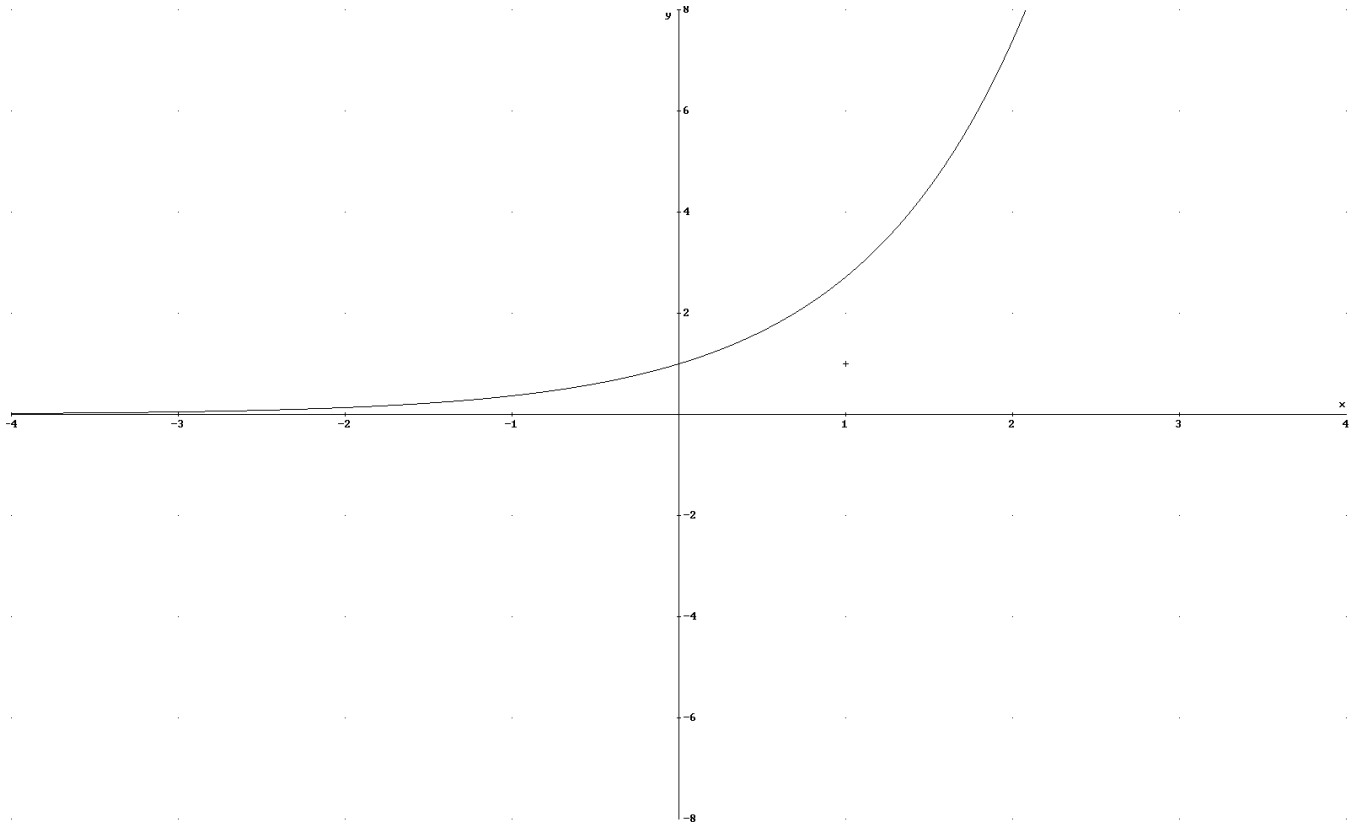


If $a, b, y, M,$ and N are positive real numbers, $a \neq 1, b \neq 1,$ and p and x are real numbers, then

1. $\log_b 1 = 0$ $(\ln 1 = 0)$
2. $\log_b b = 1$ $(\ln e = 1)$
3. $\log_b b^x = x$ $(\ln e^x = x)$
4. $b^{\log_b x} = x, x > 0$ $(e^{\ln x} = x, x > 0)$
5. $\log_b MN = \log_b M + \log_b N$
 $(\ln MN = \ln M + \ln N)$
6. $\log_b \frac{M}{N} = \log_b M - \log_b N$ $\left(\ln \frac{M}{N} = \ln M - \ln N \right)$
7. $\log_b M^p = p \log_b M$ $(\ln M^p = p \ln M)$
8. $\log_b M = \log_b N$ *if and only if* $M = N$
 $(\ln M = \ln N$ *if and only if* $M = N)$
9. $\log_{10} M = \log M$
10. $\log_e M = \ln M$
11. $\log_b M = \frac{\log_a M}{\log_a b} = \frac{\ln M}{\ln b} = \frac{\log M}{\log b}$
12. $y = b^x$ *is equivalent to* $x = \log_b y$
 $(y = e^x$ *is equivalent to* $x = \ln y)$

$$y = f(x) = e^x$$



Domain: $(-\infty, \infty)$

Range: $(0, \infty)$

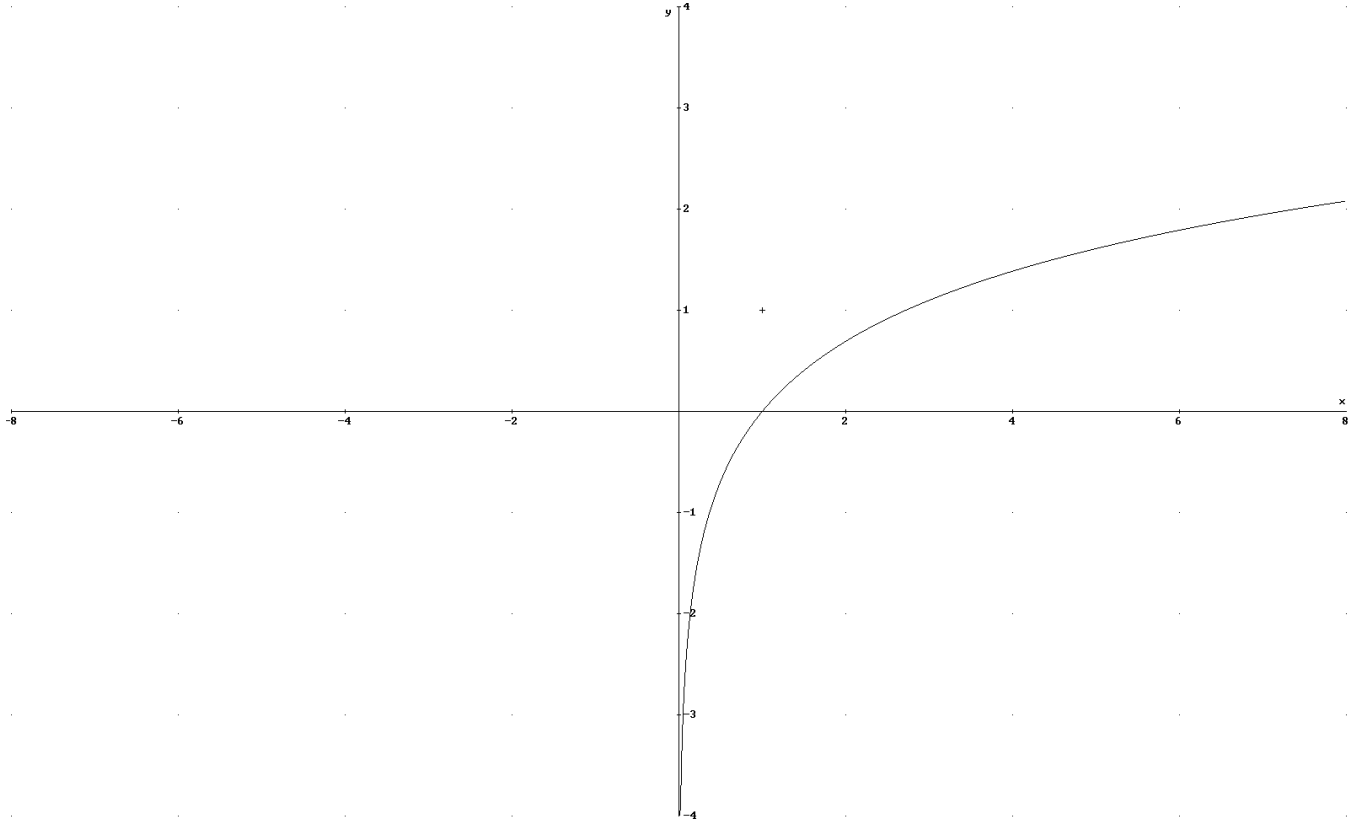
y-intercept = $(0, 1)$

Horizontal Asymptote: $y = 0$

$$\lim_{x \rightarrow \infty} e^x = \infty$$

$$\lim_{x \rightarrow -\infty} e^x = 0$$

$$y = f(x) = \log_e x = \ln x$$



Domain: $(0, \infty)$

Range: $(-\infty, \infty)$

x-intercept = $(1, 0)$

Vertical Asymptote: $x = 0$

$$\lim_{x \rightarrow \infty} \ln x = \infty$$

$$\lim_{x \rightarrow 0^+} \ln x = -\infty$$