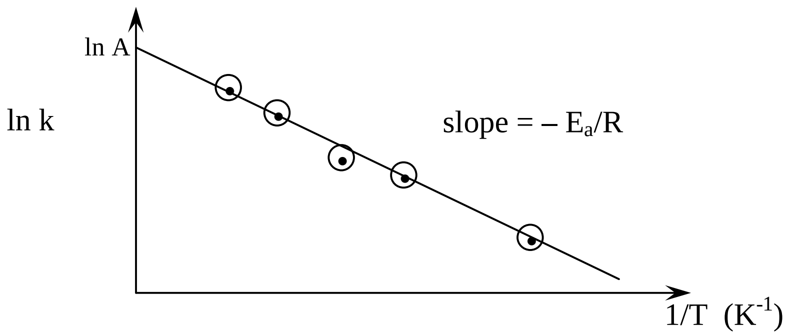
General Pattern 4: Exponential Temperature Dependence: $e^{-E/RT}$

$$k = A\, e^{-E_a/RT}$$

$$\ln k = \ln A - \frac{E_a}{RT}$$

$$\ln \frac{k_{T2}}{k_{T1}} = -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$



$$\ln k = -\frac{E_a}{RT} + \ln A$$

$$y \quad = \quad mx \quad + \quad b$$

$$\ln k_{T2} = -\frac{E_a}{R}\left(\frac{1}{T_2}\right) + \left(\frac{E_a}{R}\left(\frac{1}{T_1}\right) + \ln k_{T1}\right)$$

$$y \quad = \quad mx \quad + \quad b$$

$$b = \left(\frac{E_a}{R}\left(\frac{1}{T_1}\right) + \ln k_{T1}\right) = \ln A$$

$$k_{T2} = k_{T1}\, e^{\frac{-E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)}$$

$$\left(\frac{1}{T_2} - \frac{1}{T_1}\right) = \left(\frac{T_1 - T_2}{T_1\, T_2}\right) = -\left(\frac{T_2 - T_1}{T_1\, T_2}\right) = -\left(\frac{\Delta T}{T_1\, T_2}\right)$$

with $\Delta T = T_2 - T_1$

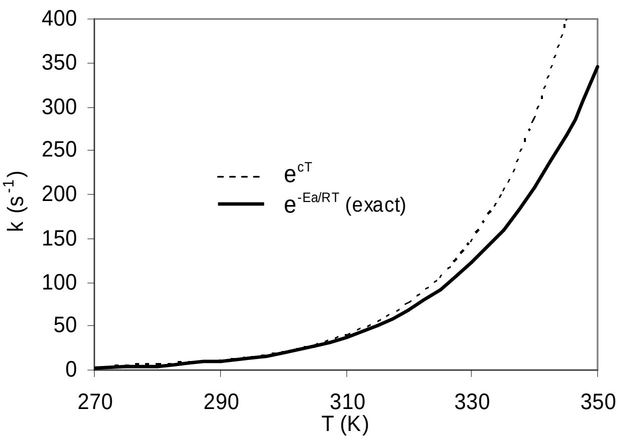
Approximation: $T_1 T_2 \approx T_1^2$:

$$\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \approx -\left(\frac{\Delta T}{T_1^2}\right)$$

$$\ln \frac{k_{T2}}{k_{T1}} = -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \approx \frac{E_a}{RT_1^2}\,\Delta T$$

ΔT small and $RT \ll E_a$:

$$k_{T2} \approx k_{T1}\, e^{\left(\frac{E_a}{RT_1^2}\right)\Delta T}$$



Alternatives to Arrhenius Behavior:

$k = a\, T^m\, e^{-E_a/RT}$ where m = 1, 2, or ±½