$$\frac{S}{k} = \ln\left(\frac{V^N}{N!}\frac{1}{h^{3N}}\frac{\pi^{3N/2}}{(3N/2)!}(2mU)^{3N/2}\right)$$

$$\approx \ln\left(\left(\frac{2\pi mU}{h^2}\right)^{3N/2}\right) + N\ln V - N\ln N + N - \frac{3N}{2}\ln\frac{3N}{2} + \frac{3N}{2}$$

$$\approx N\left[\ln\left(\left(\frac{2\pi mU}{h^2}\right)^{3/2}\right) + \ln\frac{V}{N} + 1 - \frac{3}{2}\ln\frac{3N}{2} + \frac{3}{2}\right]$$

$$\approx N\left[\ln\left(\left(\frac{2\pi mU}{h^2}\frac{2}{3N}\right)^{3/2}\right) + \ln\frac{V}{N} + \frac{5}{2}\right]$$

$$\approx N\left[\ln\left(\frac{V}{N}\left(\frac{4\pi m}{3h^2}\frac{U}{N}\right)^{3/2}\right) + \frac{5}{2}\right]$$

Sakur-Tetrode equation

$$\frac{S}{k} = N\left[\ln\left(\frac{V}{N}\left(\frac{4\pi m}{3h^2}\frac{U}{N}\right)^{3/2}\right) + \frac{5}{2}\right]$$