The entropy of all system at zero absolute temperature is a universal constant that can be taken to be zero. $\lim_{x \to 0} S(X, T) = 0$

Consequence:

1. $S(T=0, X) = 0$ for all coordinates X

   $\lim_{T \to 0} \left.\frac{\partial S}{\partial X}\right|_T = 0$

2. Heat capacity must vanish as $T \to 0$

   since $S(T, X) - S(0, X) = \int_0^T dT' \frac{C_x(T')}{T'}$ and the integral diverges

   as $T \to 0$ unless $\lim_{T \to 0} C_x(T) = 0$

3. Thermal expansivities also vanish as $T \to 0$ since

   $$\alpha_J = \frac{1}{X} \left.\frac{\partial X}{\partial T}\right|_J \underline{\text{Maxwell relation}} \frac{1}{X} \left.\frac{\partial S}{\partial J}\right|_T \overset{1.}{=} 0$$

weaker statement for 3rd law 4. impossible to cool any system to absolute zero in a finite number of steps.