

For N₂ gas molecules in a 10 cm cubic box, the rules of QM dictate the discrete allowed values for:

1. Translational K.E. in one dimension: $\{1 \times 10^{-40} \text{ J}, 4 \times 10^{-40} \text{ J}, 9 \times 10^{-40} \text{ J}, \dots\}$
2. Rotational K.E.: $\{0 \text{ J}, 0.8 \times 10^{-22} \text{ J}, 0.8 \times 10^{-22} \text{ J}, 0.8 \times 10^{-22} \text{ J}, 2.5 \times 10^{-22} \text{ J}, \dots\}$
3. Vibrational energy: $\{2.3 \times 10^{-20} \text{ J}, 6.9 \times 10^{-20} \text{ J}, 11.5 \times 10^{-20} \text{ J}, \dots\}$

Sketch a graph of $\frac{dU}{dT}$ of 10^{22} molecules of N₂ gas in the temperature range of 70 K (the temperature at which N₂ becomes liquid at 1 atm of pressure) to 5000 K (at which temperature N₂ breaks apart).

(use a logarithmic temperature axis)