

For one mole of O_2 at 298K and 1 atm, calculate:

1. The fraction of molecules in the 3rd vibrational energy level (vibrational quantum number 3).
2. The fraction of molecules that are in the vibrational energy levels lower than the 3rd ($j = 0, 1, 2$).
3. The vibrational contribution to the internal energy.
4. The sum of vibrational, rotational, and translational internal energy.
5. The entropy for one mole of gas.

The vibrational wave number for $O_2 = 1556.3 \text{ cm}^{-1}$. θ_r of O_2 is 2.08 K.