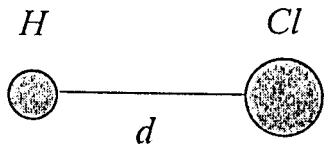
SM7a1199A

Consider an ideal gas of HCl molecules.



(a) Find the moment of inertia I of the diatomic molecules around their center of mass in terms of the atomic separation d and the masses m_H and m_{Cl}, which you can consider to be point masses.

(b) What is the rotational heat capacity per molecule of the gas in the classical (high temperature) limit?

(c) Find the energy levels E_J and their degeneracies for rotational motion of each molecule in terms of the moment of inertia I and the rotational quantum number J.

(d) Find an exact expression for the rotational entropy of N molecules of the gas.

(e) Find the leading asymptotic behaviors of the rotational entropy and the rotational heat capacity of N molecules of the gas as a function of temperature in the low temperature regime.

(f) Find the leading asymptotic behavior of the rotational entropy of N molecules of the gas at high temperatures. Show that this yields the expected classical heat capacity in the high temperature limit.