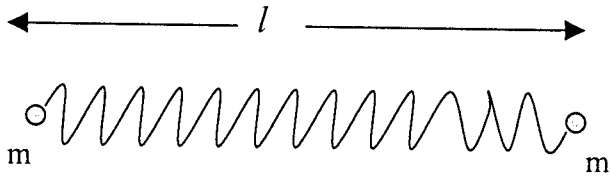
SM 7a1100A



Consider the following model of a diatomic molecule free to move in 3 dimensions. The model is that two point-like particles of mass m are connected by a spring with spring constant k_S. The spring has equilibrium length l and remains perfectly linear. Assume all velocities are small compared to the speed of light. The molecule is in thermal equilibrium with a reservoir at temperature T. Express your answers in terms of m, k_S, l, Boltzmann's constant k_B, T, and Planck's constant h.

A) State an inequality that ensures that the classical thermal oscillations have little effect on the moment of inertia.

B) Assuming that inequality (A) holds, what is the expectation value of the total thermal energy in the classical regime?

C) State an inequality needed to ensure that classical statistical mechanics does indeed apply to the oscillations.

D) For the regime of (C), estimate the dimensionless entropy, S/k_B due to oscillations.

E) State an inequality needed to ensure that classical statistical mechanics does indeed apply to the rotations.

F) For the regime of (E), estimate the dimensionless entropy due to rotations.