University of California Santa Cruz Physics Department

Statistical Mechanics 219 SQ 2018

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Homework 1
Solve by 14 April 2018

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1. Consider a one-dimensional (1D) particle with the quadratic dispersion $\xi_p = \frac{p^2}{2m}$ in an infinite rectangular potential well

$$U(x) = \begin{cases} 0, & |x| < a/2, \\ \infty, & |x| > a/2. \end{cases}$$

(a) Find the phase trajectories of the system and plot them in the phase plane.

(b) Compute the area enclosed by the phase trajectory of a particle of energy ε.

(c) Derive the Bohr-Sommerfeld quantisation rule for this system.

2. (2D Maxwell distribution.) Derive the Maxwell distribution for a 2D gas of quadratically-dispersing molecules.

Hint: to find the coefficient in the exponent, use the equation of state in the form $P = nT$, where n is the 2D concentration of the molecules.

3. Compute the most probable kinetic energy of a molecule in a classical ideal gas (3D), i.e. such a value of the kinetic energy ε that the number of molecules in a given infinitesimal interval of energy $d\varepsilon$ around this value is maximal.

4. Compute the temperature for which the number of molecules in the velocity interval $(v, v + dv)$ in a classical ideal gas is maximal.

5. Compute the average value $\left\langle \frac{1}{p} \right\rangle$ of the inverse momentum p in a classical ideal gas.