

PHY 3513 Fall 1998 – Homework 3

Due at the start of class on Friday, September 18.

Answer both questions. Please explain your reasoning and show all working, write neatly and remember to include your name on the front page of your answers.

1. In class we computed the entropy change during the free expansion of n moles of ideal gas from initial volume V_i to final volume V_f . Using the fact that S is a state function, we computed ΔS for the free expansion (an irreversible process) by looking at an isothermal expansion (a reversible process).

Repeat the calculation of ΔS for the free expansion, this time by looking at a two-step reversible process between the initial and final states: a constant-pressure expansion from V_i to V_f , followed by a constant-volume cooling to the final state. Include a sketch of the two reversible steps on a P - V diagram.

2. Consider a box containing a gas of N point-like molecules which do not interact with one another. The box is considered to be divided into two equal parts. (The division is imaginary — no physical barrier separates the parts.)

(a) For the case $N = 20$, calculate the probability of finding exactly (i) $N/2$, (ii) $N/2 - 1$, (iii) $N/4$, and (iv) 1 molecule in the left half of the box.

(b) For the case $N = 40$, calculate the probability of finding exactly (i) $N/2$, (ii) $N/2 - 1$, (iii) $N/4$, and (iv) 1 molecule in the left half of the box.

Note: Do not use Stirling's approximation. Most scientific calculators are able to compute N directly for $N \leq 69$.