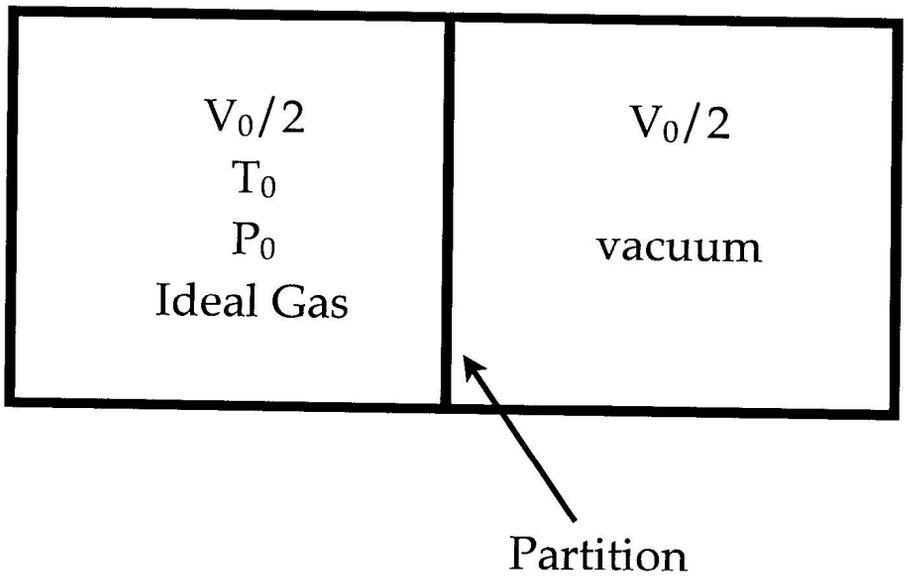
Question #1

A vessel of volume V_o is perfectly insulated from the environment, and contains a partition locked into place that divides the volume in half. On the left side of the partition is 1 mole of ideal gas at a temperature T_o and pressure P_o. On the right side of the partition there is vacuum.



Part A: The partition is released, and the gas is allowed to expand. Is this process reversible or irreversible, and why?

Part B: Calculate the work done by the gas during the expansion, and the final temperature of the system after the expansion is complete.

Part C: What is the change in entropy of the system for this process?

Part D: Now, I interact with the system to return the partition to its initial position adiabatically. Calculate the change in internal energy and entropy for this process.

Part E: What would be the entropy change if I returned the gas to its initial state, $(V_o/2, T_o, P_o)$?

Question #2

It can be shown that the internal energy per mole of a van der Waals fluid is:

$$u = \frac{3}{2}RT - a\rho$$

where R is the gas constant, T is temperature, and ϱ is the molar density.

Part A: For a given volume, mole number, and temperature, which system will have a lower internal energy, an ideal gas or a van der Waals fluid? Why?

Part B: Calculate the constant volume heat capacity of a van der Waals fluid, and compare it to the constant volume heat capacity of an ideal gas.

Part C: Calculate the dependence of a van der Waals fluid's internal energy on molar volume, $\left(\frac{\partial U}{\partial V}\right)_T$, and compare it to the same for an ideal gas.