A Problem from a Previous Exam

A container with a volume $V = 100 \, \text{cm}^3$ has a small circular hole with an area $A = 0.1 \, \text{mm}^2$. There is an equimolar mixture of He (4 g/mol) and Ar (40 g/mol) in the container at an initial pressure of $10^{-5} \, \text{atm}$ and temperature of 273K. The container is located inside of a large vacuum chamber where the pressure is very much less than $10^{-5} \, \text{atm}$.

(a) Calculate the pressure in the container at a time $t = 1 \, \text{s}$ after the flow through the hole is initiated, assuming that the temperature of the gas in the container remains constant. For this situation, take $Kn >> 1$.

(b) What is the composition (i.e., the mole fractions of He and Ar) of the gas left in the container after 10 s.

(c) How much does the internal energy of the system comprising the gas within the container change from $t = 0$ to $t = 10 \, \text{s}$. Express your answer in Joules (J).