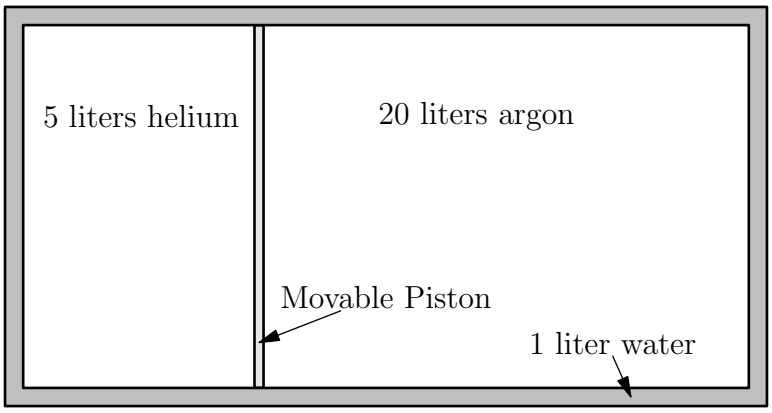
J03T.1—Container of Gases

Problem

A container is filled with 5 liters of helium gas and 20 liters of argon gas separated by a movable thin piston. The walls of the container are hollow and are filled with one liter of water. The heat capacity of the piston and the container walls are negligible. The piston is initially in its rest position, and the water and the gas are in thermal equilibrium at a temperature of 32°C.



One moves the piston slowly, while maintaining thermal equilibrium, to the point where the pressure of the argon gas is twice its original value. Then, suddenly, the piston is released. The piston returns to its rest position and thermal equilibrium is restored. After the entire process the temperature of the water has increased by exactly 1.0° C. The heat capacity of water is 4.184 kJ/kg·K, and the gas constant is $R = 8.314$ J/mole·K.

a) How many moles of helium and argon are inside the container?

Next, the water is removed from the walls and the same process is repeated but now without the water.

b) What is the pressure of the gas before and after this second process? Express your answer in units of 1 atmosphere $= 1.01 \times 10^5$ N/m^2.

c) Determine the change in entropy during the first process and the second process. Is there a difference? Explain.