2. Two cylinders A and B of equal capacity are connected to each other via a stopcock. A contains a gas at standard temperature and pressure. B is completely evacuated. The entire system is thermally insulated. The stopcock is suddenly opened. Answer the following:

i. What is the final pressure of the gas in A and B?
ii. What is the change in internal energy of the gas?
iii. What is the change in the temperature of the gas?
iv. Do the intermediate states of the system (before settling to the final equilibrium state) lie on its P-V-T surface?

Sol.

i. Since the final temperature and initial temperature remain the same.
$\therefore P_2V_2 = P_1V_1$
But $P_1 = 1$ atm, $V_1 = V$, $V_2 = 2V$ and $P_2 = ?$
$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{1\times V}{2V} = 0.5$ atm

ii. Since the temperature of the system remains unchanged, the change in internal energy is zero.

iii. The system being thermally insulated, there is no change in temperature (because of free expansion)

iv. The expansion is a free expansion. Therefore, the intermediate states are non-equilibrium states and the gas equation is not satisfied in these states. As a result, the gas can not return to an equilibrium state which lies on the P-V-T surface.