Answer on Question # 58245 – Physics – Molecular Physics | Thermodynamics

On a P-V diagram starting from an initial state P_0V_0 plot an adiabatic expansion to $2V_0$, an isothermal expansion to $2V_0$ and an isobaric expansion to $2V_0$.

a) Use this graph to determine in which process the least work is done by the system.

b) If, instead, the substance was compressed to $V_0/2$, in which process would the least work done?

c) Plot the processes of parts (a) and (b) on P-T diagram starting from P_0T_0. Indicate expansions and compressions and be careful to show relative positions at the endpoints of each process.

Solution:

a) The work of the system in the process is numerically equal to the area under the plot of the process on a P-V diagram. As can be seen from the graph (Figure 1), the system does the least work in the process of adiabatic expansion, since the value of adiabatic line (k) always exceeds 1.

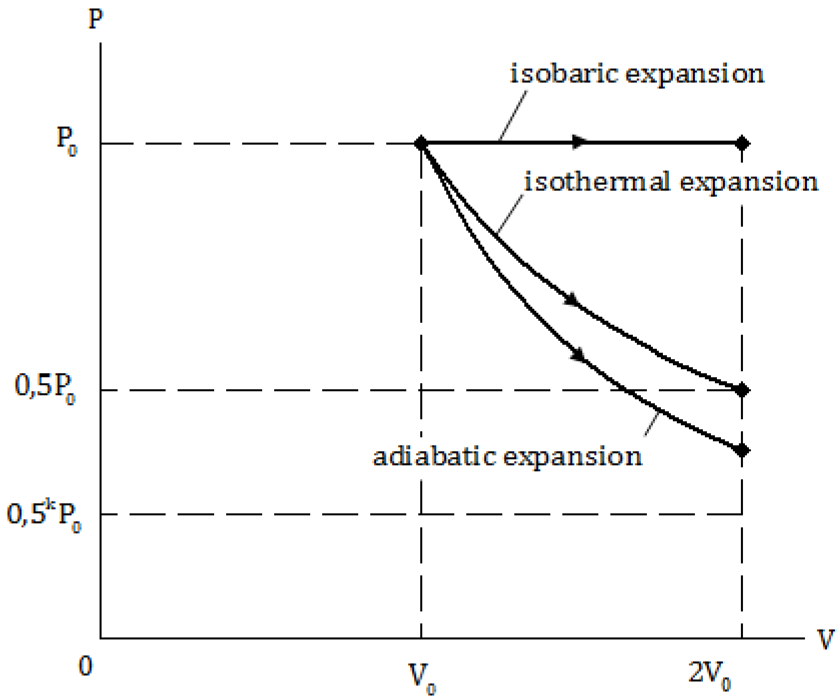

Figure 1 – System expansion (P-V diagram)

b) As can be seen from Figure 2, the least work is exerted to the system in the process of isobaric compression.

However, the system itself does negative work during its compression. In these terms, the least negative work done by the system is the one with the largest module; therefore, the system itself does the least work in the process of adiabatic compression.

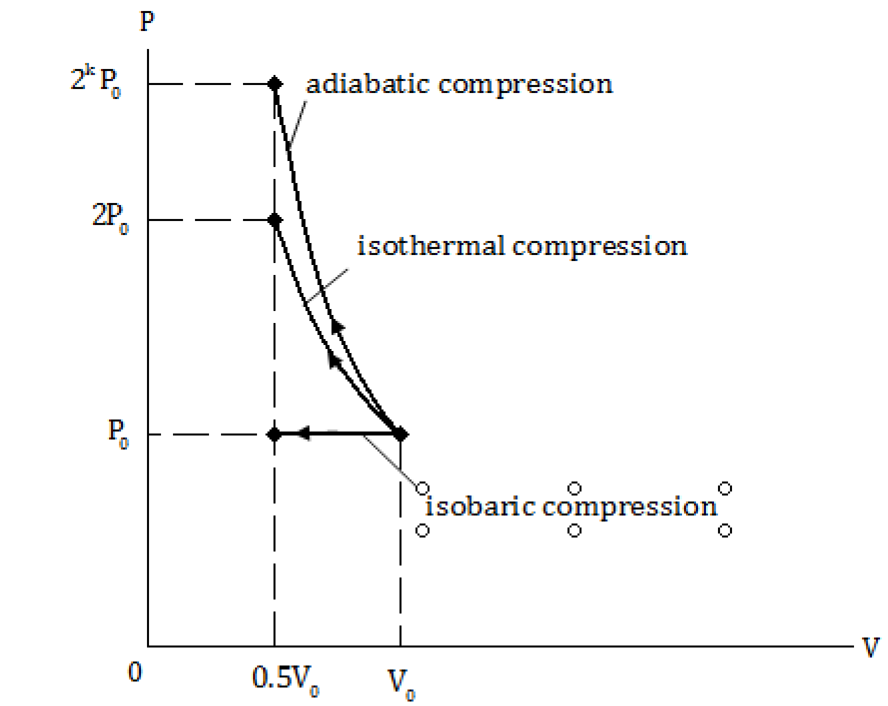

Figure 2 – System compression (P-V diagram)

c) The processes of expansions and compression are shown on the P-T diagram (Figure 3).

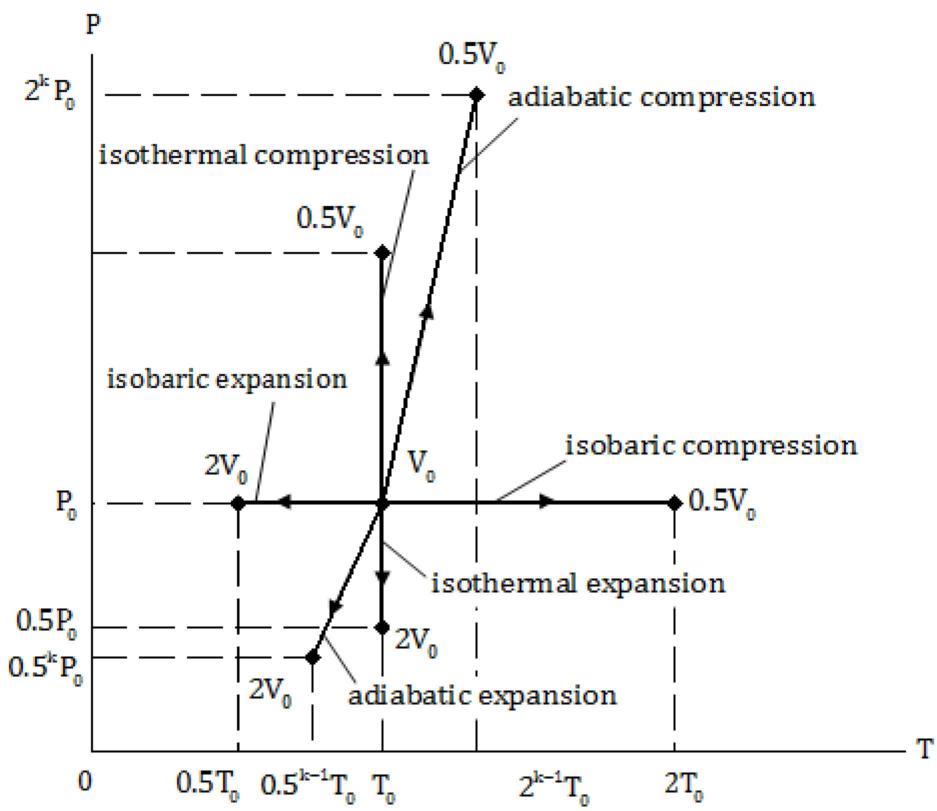

Figure 3 – System expansion and compression (P-V diagram)

Answer: a) the least work is done by the system in the process of adiabatic expansion;

b) the least work is exerted to the system in the process of isobaric compression;

c) the relative values of the system parameters in the end of each process are as follows:

Process	V	P	T	Equation
Adiabatic expansion	$2V_0$	0.5^kP_0	0.5^kT_0	PV^k = const, TV^{k-1} = const
Isothermal expansion	$2V_0$	$0.5P_0$	T_0	PV = const
Isobaric expansion	$2V_0$	P_0	$0.5T_0$	V/T = const
Adiabatic compression	$0.5V_0$	2^kP_0	2^kT_0	PV^k = const, TV^{k-1} = const
Isothermal compression	$0.5V_0$	$2P_0$	T_0	PV = const
Isobaric compression	$0.5V_0$	P_0	$2T_0$	V/T = const