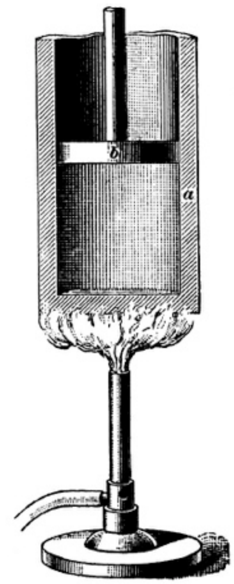
Name______________________________Pd________

PV Diagrams, etc.



A piston contains an ideal gas at a pressure of $2.02 \cdot 10^5$ Pa. The volume starts at 0.005 m^3, and the temperature is –23°C. The gas is heated at a constant volume to a pressure of 404 kPa and then at a constant pressure to a temperature of 650 K. The gas is then cooled at a constant volume to its original pressure and then at a constant pressure to its original volume. The gas has a molar mass of 2 g/mol.

A) On the axes below, draw a PV diagram for the entire cycle; don't forget to label the temperature at each point.
B) Determine the mass of the gas.
C) Determine the heat input for the first and second processes.
D) Determine the heat output for the third and fourth processes.
E) Is work done by the gas or on the gas for the entire cycle. Explain your answer and determine that amount of work.

First we'll find the second temp. using $P_1V_1/T_1 = P_2V_2/T_2 \rightarrow T_2 = P_2T_1/P_1$

$T_2 = (4.04)(250)/(2.02) = 500$ K (notice I've dropped out the common factor of $\cdot 10^5$)

Second we'll find the third volume using $P_1V_1/T_1 = P_2V_2/T_2 \rightarrow V_2 = V_1T_2/T_1$

$V_2 = (0.005)(650)/(500) = 0.0065$ m^3

Third we'll find the fourth temperature using $P_1V_1/T_1 = P_2V_2/T_2 \rightarrow T_2 = P_2T_1/P_1$

$T_2 = (2.02)(650)/(4.04) = 325$ K (notice I've dropped out the common factor of $\cdot 10^5$ again)

For part B) We'll use: $PV=nRT \rightarrow n=PV/RT = (2)(5)/(.0821)(250) = 0.487$ mol

$0.487 \text{ mol} \cdot 2 \text{ g/mol} = 0.974$ g

For part C) We'll use $Q_{in}=W_{out}+\Delta U$ For the first process, W=0 since there's no area,

so $Q_{in} = \Delta U = 3/2nR\Delta T = (1.5)(.487)(8.314)(250) = 1518$ J

For the second process, W=area under the graph ($W=P\Delta V = (4.04 \cdot 10^5)(0.0015) = 606$ J)

$Q_{in}=W_{out}+\Delta U = 606 + 3/2(.487)(8.314)(150) = 606 + 911 = 1517$ J

For part D) We'll use $Q_{in}=W_{out}+\Delta U$ For the third process, W=0 since there's no area,

so $Q_{in} = \Delta U = 3/2nR\Delta T = (1.5)(.487)(8.314)(-325) = -1974$ J

For the fourth process, W=area under the graph ($W=P\Delta V = (2.02 \cdot 10^5)(-0.0015) = -303$ J)

$Q_{in}=W_{out}+\Delta U = -303 + 3/2(.487)(8.314)(-75) = -303 + -455.5 = -758.5$ J

For part E) Work is done BY THE GAS for the entire cycle, since the area under the expansion (the second process) is greater than the area under the compression (the fourth process). If we look at the work from both of these, there is a difference of 303 J