Name______________________________ Pd________

P–V Diagrams

A cylinder contains an ideal gas at a pressure of 2 atm. The volume of the gas is 5 liters, and the temperature is 250 K. The gas is heated at a constant volume to a pressure of 4 atm.

NOTE: We're using the Equation of Flux at the beginning, so we don't need to do conversions unless temperature is in Celsius.

A) What is the new temperature of the gas?

We'll use $P_1V_1/T_1 = P_2V_2/T_2 \rightarrow T_2 = P_2T_1/P_1$

$T_2 = (4)(250)/(2) = 500$ K

The gas is now kept at a constant pressure and heat is added until the temperature is 650 K.

B) What is the new volume of the gas?

We'll use $P_1V_1/T_1 = P_2V_2/T_2 \rightarrow V_2 = V_1T_2/T_1$

$V_2 = (5)(650)/(500) = 6.5$ L

The gas is then cooled to its original pressure, while its volume is held constant.

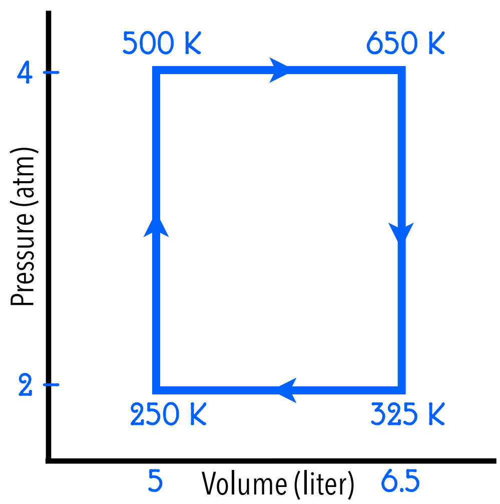
C) What is the new temperature of the gas?

We'll use $P_1V_1/T_1 = P_2V_2/T_2 \rightarrow T_2 = P_2T_1/P_1$

$T_2 = (2)(650)/(4) = 325$ K

Finally, the gas is taken at a constant pressure back to its original volume.

D) Draw and label a PV diagram for the entire process described above……..



E) Assuming the gas has a molar mass of 2 g/mol, what is the mass of the gas at each point?

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 (which stays constant)

F) From the second state of the gas to its third state, was work done ON THE GAS or BY THE GAS? How much?

Normalizing units: $4 \text{ atm} = 4 \cdot 10^5$ Pa and $1.5 \text{ L} = 0.0015 \text{ m}^3$

We'll use: $W = P\Delta V = (4 \cdot 10^5)(.0015) = 600$ J by the gas

(Since the volume increased, the gas pushed the piston outward, doing work)

G) From the fourth state of the gas back to the original state, was work done ON THE GAS or BY THE GAS? How much?

Normalizing units: $2 \text{ atm} = 2 \cdot 10^5$ Pa

We'll use: $W = P\Delta V = (2 \cdot 10^5)(-.0015) = -300$ J by the gas, which is +300 J on the gas

(The volume decreased, so the piston pushed the gas inward, doing work on the gas)

H) During which transitions was heat added to the gas? During which did the gas give off heat? What's the total work done by or on the gas for the entire cycle? Why is it zero (or why isn't it)?

Heat was added during transitions 1 and 2, the gas gave off heat during transitions 3 and 4
The total work done BY THE GAS is equal to the area enclosed by the cycle, which is 300 J
It is positive (by the gas) because the expansion area is greater than the compression area.
It is not zero because the area of a complete cycle can never be zero.