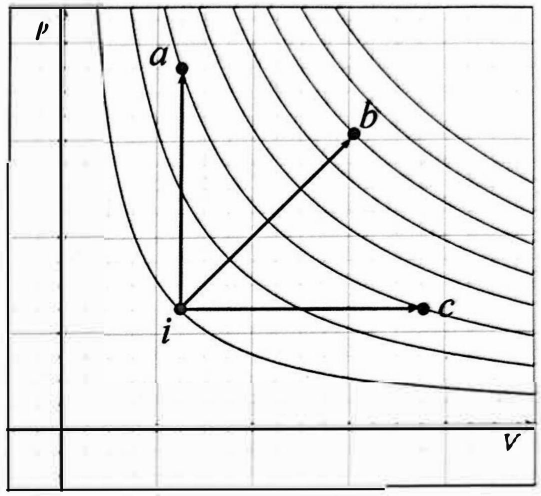
Group Members:

1. An ideal gas starts at an initial state i and is being taken toward three different final states: a, b, and c via three different thermodynamical processes: $i \to a, i \to b, i \to c$.



   a. Through which process will the pressure of the ideal gas remain unchanged?

   i->c is the isobaric process through which the pressure will remain unchanged.

   b. Through which process will the volume of the ideal gas remain unchanged?

   i->a is the isochoric process through which the volume will remain unchanged.

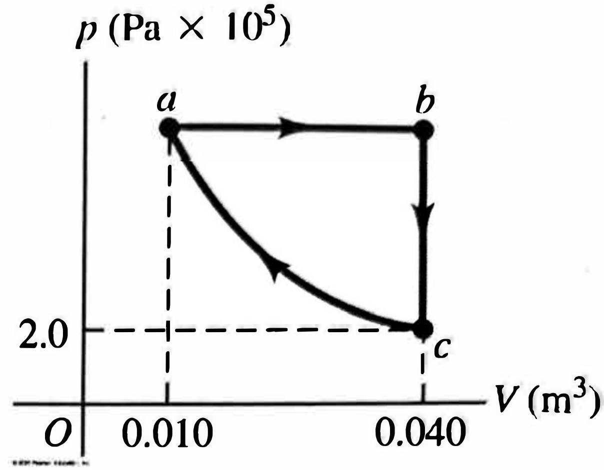
   c. Will the temperature T_a at a be smaller, larger, or the same as the temperature T_b at b?

   state b is on an isothermal further to the top-right corner from the origin in the PV diagram than state a so $T_b > T_a$.

   d. Will the temperature ~~T_b~~ T_a at ~~b~~ a be smaller, larger, or the same as the temperature T_c at c?

   state c and state a are the same isotheral so $T_a = T_c$.

2. An ideal gas is being taken through a thermodynamic cycle as shown in the right figure. The process $c \to a$ is a isothermal compression. ($C_v = 3R/2$)



a. Knowing the process $c \to a$ being an isothermal process, calculate the the pressure P_a at state a. (Use the Ideal Gas Law)

$$\frac{P_a V_a}{\cancel{T_a}} = \frac{P_c V_c}{\cancel{T_c}} \qquad T_a = T_c$$

$$P_a = \left(\frac{V_c}{V_a}\right) P_c = \left(\frac{0.040\ m^3}{0.010\ m^3}\right)(2.0 \times 10^5\ Pa)$$

$$= 8.0 \times 10^5\ Pa$$

b. Calculate the work done through the process $a \to b$.

$a \to b$ is an isobaric process, so $P_a = P_b = 8.0 \times 10^5\ Pa$

$$W_{ab} = P_a (V_b - V_a)$$

$$= (8.0 \times 10^5\ Pa)(0.040 - 0.010)\ m^3$$

$$= 2.4 \times 10^4\ J$$

c. Calculate the work done through the process $b \rightarrow c$.

b->c is an isochoric process with volume change.

So, $W_{bc} = 0\,J$.

d. Calculate the work done through the process $c \rightarrow a$.

This is an isothermal process.

$$P_a V_a = nRT_a$$

$$T_a = \frac{P_a V_a}{nR}$$

$$W_{ca} = nRT_a \ln\left(\frac{V_a}{V_c}\right)$$

$$= \cancel{(nR)} \frac{P_a V_a}{\cancel{(nR)}} \ln\left(\frac{V_a}{V_c}\right)$$

$$= (8.0\times10^5\,Pa)(0.010\,m^3)\ln\left(\frac{0.010}{0.040}\right) = -1.1\times10^4\,J$$

e. What is the *net* work done W_{net} through one complete cycle?

$$W_{net} = W_{ab} + W_{bc} + W_{ca}$$

$$= 2.4\times10^4\,J + 0\,J - 1.1\times10^4\,J$$

$$= 1.3\times10^4\,J$$

Problem 3

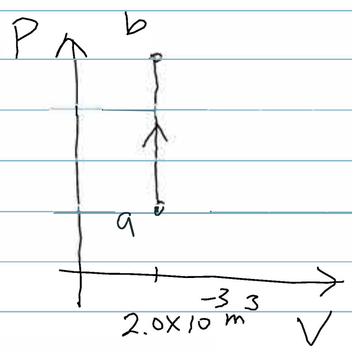
Note: ① Do it process by process

② U is a state variable → ΔU depends on states only not on path

③ Q & W depend on path.

④ Use 1st law!

a). ΔU_{ab} ?



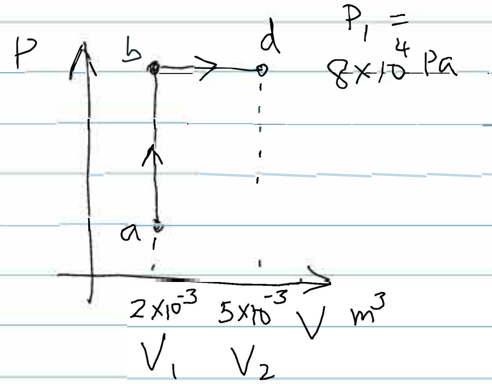
Since $\Delta V_{ab} = 0$, $W_{ab} = 0$

$Q_{ab} = 150J$ given

Apply 1st law:

$$\Delta U_{ab} = Q_{ab} - W_{ab} = \underline{\underline{150J}}$$

b). ΔU_{abd} ?



$$W_{bd} = P_1 (V_2 - V_1)$$

$$= (8 \times 10^4 Pa)(5-2) \times 10^{-3} m^3$$

$$= 240J$$

$Q_{bd} = 600J$ given

Apply 1st law again:

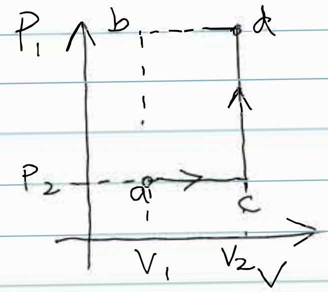
$$\Delta U_{bd} = Q_{bd} - W_{bd} = 600J - 240J$$

$$= 360J$$

Now, $\Delta U_{abd} = \Delta U_{ab} + \Delta U_{bd} = 150J + 360J$

$$= 510J$$

c). Q_{acd} ?



$$W_{ac} = P_2 (V_2 - V_1)$$

$$= (3.0 \times 10^4 Pa)(3.0 \times 10^{-3} m^3)$$

$$= 90J$$

$W_{cd} = 0$ since $\Delta V = 0$

So, $W_{acd} = W_{ac} + W_{cd} = 90J$

1st law gives: $\Delta U_{acd} = Q_{acd} - W_{acd}$

$$Q_{acd} = \Delta U_{acd} + W_{acd}$$

Now, we use the fact that ΔU depends only states only

So, $\Delta U_{acd} = \Delta U_{abd}$!

$\Rightarrow Q_{acd} = \Delta U_{abd} + W_{acd} = 510J + 90J = \underline{600J}$