

```
In [1]: #####  
# Futures  
%matplotlib inline  
# from __future__ import unicode_literals  
# from __future__ import print_function  
  
# Generic/Built-in  
import datetime  
import argparse  
  
# Other Libs  
from IPython.display import display, Image  
from sympy import *  
import matplotlib.pyplot as plt  
import numpy as np  
  
# Owned  
# from nostalgia_util import log_utils  
# from nostalgia_util import settings_util  
__authors__ = ["Osamu Katagiri - A01212611@itesm.mx"]  
__copyright__ = "None"  
__credits__ = ["Marcelo Videa - mvideo@itesm.mx"]  
__license__ = "None"  
__status__ = "Under Work"  
#####
```

Exercise 1 & 2

```
In [10]: display(Image(filename='./directions/1_2.jpg'))
```

- 1. Read the article by S. M. Blinder “Mathematical Methods in Elementary Thermodynamics”.
- 2. Use what you learnt from your reading to calculate  $(\partial \bar{V} / \partial T)_P$  and  $(\partial \bar{V} / \partial P)_T$  for a van der Waals gas.

$$\left(P + \frac{a}{\bar{V}^2}\right) (\bar{V} - b) = RT$$

Blinder, S. M. (1966). Mathematical methods in elementary thermodynamics. Journal of Chemical Education, 43(2), 85.  
<https://doi.org/10.1021/ed043p85> (<https://doi.org/10.1021/ed043p85>) <https://github.com/WolframResearch/WolframLanguageForJupyter>  
(<https://github.com/WolframResearch/WolframLanguageForJupyter>)

Exercise 1 & 2 - part A

Let's calculate

$$\left(\frac{\partial V}{\partial T}\right)_P$$

from

$$dP = \left(\frac{\partial P}{\partial V}\right)_T dV + \left(\frac{\partial P}{\partial T}\right)_V dT$$

supposing that

$$P(V, T) = constant$$

so that

$$dP = 0$$

if

$$\left(\frac{\partial P}{\partial V}\right)_T dV + \left(\frac{\partial P}{\partial T}\right)_V dT = 0$$

then

$$\left(\frac{\partial V}{\partial T}\right)_P = -\frac{\left(\frac{\partial P}{\partial T}\right)_V}{\left(\frac{\partial P}{\partial V}\right)_T}$$

Let's use Mathematica to compute

$$\left(\frac{\partial P}{\partial V}\right)_T$$

In [1]:

D[Solve[(P + a/V^2)\*(V - b) == R\*T, P], V] //ToRadicals //First //First //FullSimplify

Out[1]:

$$\emptyset \rightarrow -\frac{RT}{(b-V)^2} + \frac{2a}{V^3}$$

Let's compute

$$\left(\frac{\partial P}{\partial T}\right)_V$$

In [4]:

D[Solve[(P + a/V^2)\*(V - b) == R\*T, P], T] //ToRadicals //First //First //FullSimplify

Out[4]:

$$\emptyset \rightarrow \frac{R}{-b+V}$$

Let's compute

$$\left(\frac{\partial V}{\partial T}\right)_P$$

In [9]:

-(R/(-b + V))/(-(R T)/(b - V)^2) + (2 a)/V^3 //ToRadicals //FullSimplify

Out[9]:

$$\frac{RV^3(-b+V)}{-2a(b-V)^2+RTV^3}$$

$$\left(\frac{\partial V}{\partial T}\right)_P = \frac{RV^3(V-b)}{-2a(b-V)^2+RTV^3}$$

Exercise 1 & 2 - part B

Let's calculate

$$\left(\frac{\partial V}{\partial P}\right)_T$$

from

$$dP = \left(\frac{\partial T}{\partial V}\right)_P dV + \left(\frac{\partial T}{\partial P}\right)_V dP$$

supposing that

$$T(V,P) = constant$$

so that

$$dT = 0$$

if

$$\left(\frac{\partial T}{\partial V}\right)_P dV + \left(\frac{\partial T}{\partial P}\right)_V dP = 0$$

then

$$\left(\frac{\partial V}{\partial P}\right)_T = -\frac{\left(\frac{\partial T}{\partial P}\right)_V}{\left(\frac{\partial T}{\partial V}\right)_P}$$

Let's use Mathematica to compute

$$\left(\frac{\partial T}{\partial V}\right)_P$$

In [10]:

D[Solve[(P + a/V^2)\*(V - b) == R\*T, T], V] //ToRadicals //First //First //FullSimplify

Out[10]:

$$\emptyset \rightarrow \frac{2ab - aV + PV^3}{RV^3}$$

Let's compute

$$\left(\frac{\partial T}{\partial P}\right)_V$$

In [11]:

D[Solve[(P + a/V^2)\*(V - b) == R\*T, T], P] //ToRadicals //First //First //FullSimplify

Out[11]:

$$\emptyset \rightarrow \frac{-b+V}{R}$$

Let's compute

$$\left(\frac{\partial V}{\partial P}\right)_T$$

```
In [12]: -((-b + V)/R)/((2 a b - a V + P V^3)/(R V^3)) //ToRadicals //FullSimplify
```

Out[12]: 
$$\frac{(b - V) V^3}{2 a b - a V + P V^3}$$

$$\left(\frac{\partial V}{\partial P}\right)_T = \frac{(b - V)V^3}{2ab - aV + PV^3}$$

### Exercise 3

```
In [5]: display(Image(filename='./directions/3.jpg'))
```

3. Two pieces of aluminum of equal mass,  $m$ , and with initial temperatures  $T_{A,0} = 400\,K$  and  $T_{B,0} = 300\,K$  are placed in thermal contact with each other but otherwise isolated from their surroundings.
- (a) Calculate the equilibrium temperature of the system.
- (b) Calculate the change in internal energies for A, B and the total system.
- (c) Calculate the change in entropy for A, B and the total system.
- (d) Plot a graph of the change in total entropy with respect of a variable  $x$ , such that  $T_A = T_{A,0} - x$  or  $T_B = T_{B,0} + x$ .  
Choose a reasonable range for  $x$  and discuss the implication of the plot obtained.

### Exercise 3 - part A

The heat transferred from the hot to the cold aluminum piece  $dq_{h\rightarrow c}$  is equal to the heat adsorbed by the cold from the hot  $dq_{c\rightarrow h}$  after they reach the final temperature,  $T_f$ .  $dq_{h\rightarrow c} = -dq_{c\rightarrow h}$   
also, if  $m$  is the mass of aluminium, then  $n = \frac{m}{M}$ ; where  $M$  is the atomic weight of aluminium.

$T_h = T_{A,0} = 400K$   
 $T_c = T_{B,0} = 300K$

Let's asume  $C_p = 0.91Jg^{-1}K^{-1}$ ,  $m = 1Kg$  and  $M = 26.982gmol^{-1}$ .  
Therefore,  $n = 37.062mol$

Since  $dq = C_p dT = n\bar{C}_p dT$ , the following can be done:

$$\begin{aligned} C_{p_{cold}} dT &= -C_{p_{hot}} dT \\ n \int_{T_c}^{T_f} \overline{C_{p_{Al}}} dT + n \int_{T_h}^{T_f} \overline{C_{p_{Al}}} dT &= 0 \\ n (T_f - T_c) \overline{C_{p_{Al}}} + n (T_f - T_h) \overline{C_{p_{Al}}} &= 0 \\ T_f &= \frac{1}{2}(T_c + T_h) \\ T_f &= \frac{1}{2}(300K + 400K) \end{aligned}$$

$$T_f = 350K$$

### Exercise 3 - part B for A

$$\begin{aligned} \Delta U_A &= C_{p_{hot}} dT \\ \Delta U_A &= C_{p_{hot}} (350K - 400K) \end{aligned}$$

$$\begin{aligned} \Delta U_A &= (-50K)C_{p_{hot}} \\ \Delta U_A &= (-50K)(0.91Jg^{-1}K^{-1}) = -45.5Jg^{-1} \\ \Delta U_A &= -45500J \end{aligned}$$

Exercise 3 - part B for B

$$\begin{aligned}\Delta U_B &= C_{p_{cold}} dT \\ \Delta U_B &= C_{p_{cold}} (350K - 300K)\end{aligned}$$

$$\begin{aligned}\Delta U_B &= (50K)C_{p_{cold}} \\ \Delta U_B &= (50K)(0.91Jg^{-1}K^{-1}) = 45.5Jg^{-1} \\ \Delta U_B &= 45500J\end{aligned}$$

Exercise 3 - part B for the total system

$$\Delta U_{isolatedSystem} = 0$$

Since energy is a conserved quantity.

Exercise 3 - part C for A

$$\begin{aligned}dS_A &= n\overline{C_{p_{Al}}} \int_{T_h}^{T_f} \frac{1}{T} dT \\ dS_A &= n\overline{C_{p_{Al}}} \ln\left(\frac{T_f}{T_h}\right) \\ dS_A &= (1000g)(0.91Jg^{-1}K^{-1})\ln\left(\frac{350K}{400K}\right)\end{aligned}$$

$$dS_A = -121.514JK^{-1}$$

Exercise 3 - part C for B

$$\begin{aligned}dS_B &= n\overline{C_{p_{Al}}} \int_{T_c}^{T_f} \frac{1}{T} dT \\ dS_B &= n\overline{C_{p_{Al}}} \ln\left(\frac{T_f}{T_c}\right) \\ dS_B &= (1000g)(0.91Jg^{-1}K^{-1})\ln\left(\frac{350K}{300K}\right)\end{aligned}$$

$$dS_B = 140.277JK^{-1}$$

Exercise 3 - part C for the total system

The total change in entropy for the system is given by the sum of the change in entropy for the hot block and the cold block.

$$\begin{aligned}dS_{isolatedSystem} &= n\overline{C_{p_{Al}}} \int_{T_c}^{T_f} \frac{1}{T} dT + n\overline{C_{p_{Al}}} \int_{T_h}^{T_f} \frac{1}{T} dT \\ dS_{isolatedSystem} &= dS_A + dS_B\end{aligned}$$

$$dS_{isolatedSystem} = -121.514JK^{-1} + 140.277JK^{-1} = 18.763JK^{-1}$$

Exercise 3 - part D

$$\Delta S = nC_p \ln\left(\frac{T_f}{T_i}\right)$$

where:

$$T_f = T_i - x \text{ for A; \& } T_f = T_i + x \text{ for B;}$$

In [5]: *# Function to compute the "next" pressure value for IRREVERSIBLE processes*

```
def S_A_(n, Cp, Ti, x):
    Tf = Ti - x;
    return n*Cp*(np.log(Tf/Ti));

def S_B_(n, Cp, Ti, x):
    Tf = Ti + x;
    return n*Cp*(np.log(Tf/Ti));

# Draw the plot's workspace
scale = 6;
plt.subplots(figsize=(3*scale, 2*scale))

# define constants
n = 1000 #g or 37.062 mol
Cp = 0.91 #J / g K
Tmin = -300 #K
Tmax = 400 #K
Tequi = 350 #K
x = np.linspace(Tmin, Tmax, 1000);

# for B
Ti_B = 300 #K
S_B = S_B_(n, Cp, Ti_B, x)
plt.plot(x, S_B, '--', linewidth=3, label='Entropy(B)');

# for A
Ti_A = 400 #K
S_A = S_A_(n, Cp, Ti_A, x)
#print(S_A)
plt.plot(x, S_A, '--', linewidth=3, label='Entropy(A)');

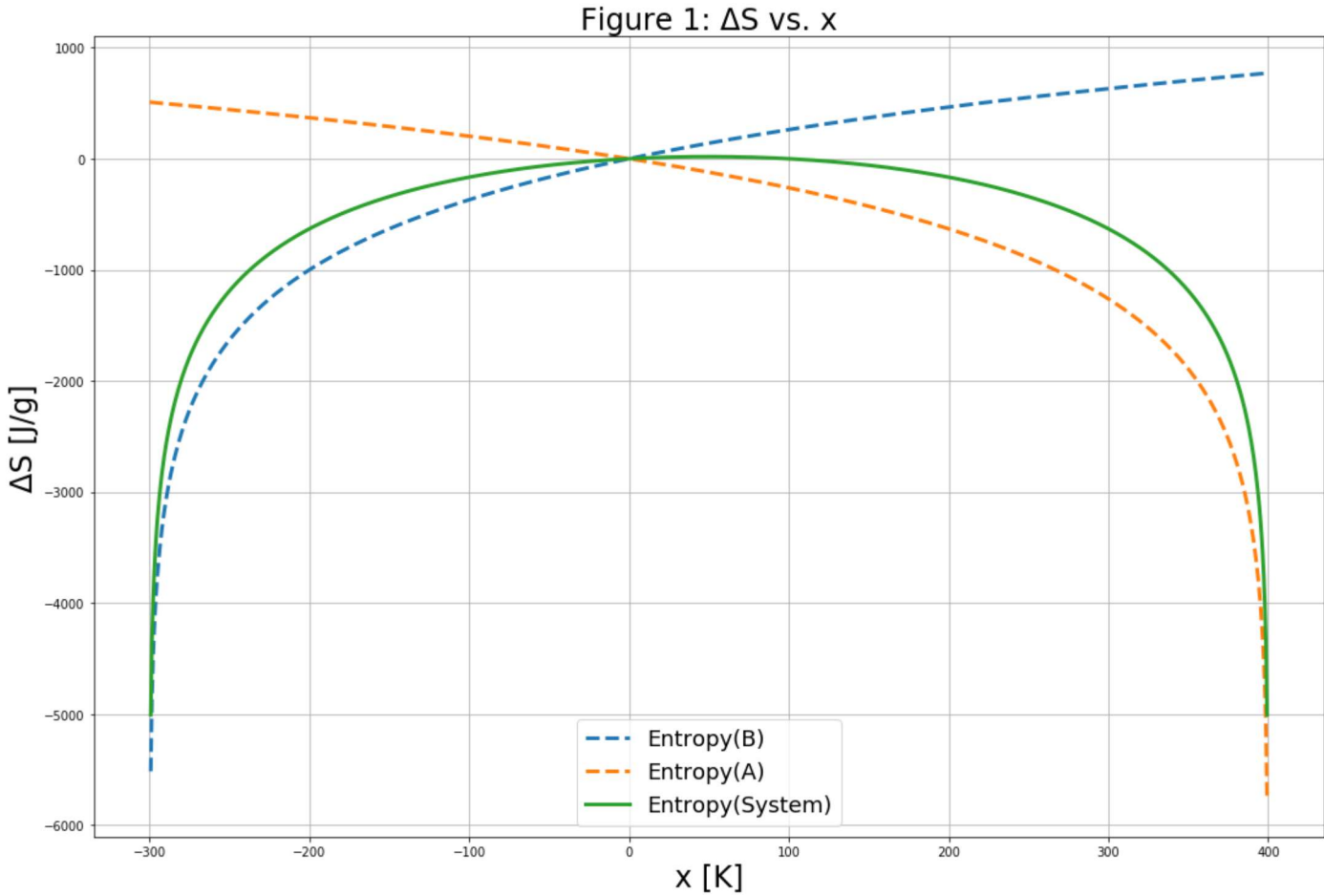
# for A+B
plt.plot(x, (S_A+S_B), '-', linewidth=3, label='Entropy(System)');

plt.xlabel('x [K]', fontsize=24);
plt.ylabel('ΔS [J/g]', fontsize=24);
plt.title("Figure 1: ΔS vs. x", size=24)
plt.legend(prop={'size': 18})
plt.grid('on')
display(plt);
```

C:\Users\oskat\Anaconda3\lib\site-packages\ipykernel\_launcher.py:8: RuntimeWarning: divide by zero encountered in log

C:\Users\oskat\Anaconda3\lib\site-packages\ipykernel\_launcher.py:4: RuntimeWarning: divide by zero encountered in log  
after removing the cwd from sys.path.

<module 'matplotlib.pyplot' from 'C:\\Users\\oskat\\Anaconda3\\lib\\site-packages\\matplotlib\\pyplot.py'>



The heat transferred from the hot to the cold aluminum piece (orange line) is equal to the heat adsorbed by the cold from the hot (blue line) after they reach the final temperature of  $350K$ .

The point where Entropy(A) meets Entropy(B) corresponds maximum entropy at the equilibrium temperature of the system.

## Exercise 4

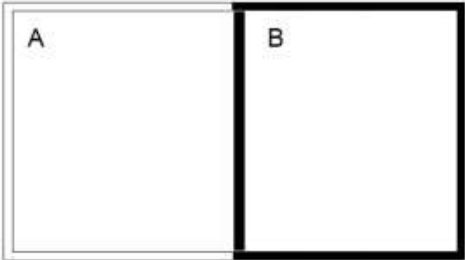
```
In [6]: display(Image(filename='./directions/4.jpg'))
```

4. Calculate  $\Delta S_A$ ,  $\Delta S_B$ ,  $\Delta S_{\text{surr}}$  and  $\Delta S_{\text{univ}}$  for Problem 4 in Homework 2.

### Problem 4 - Hwk 02

```
In [17]: display(Image(filename='./directions/4_1.jpg'))
```

4. A semi-insulated system, as shown bellow, is formed by a container that has two compartments, A and B, separated by an movable adiabatic wall. Each compartment has an initial volume of 5 L and 1 atm of pressure. Each contains 0.5 mole of a perfect monoatomic gas.



In the beginning, the temperatures of A and B are the same. Then, the gas A expands and displaces the gas B is compressed in a reversible and adiabatic way until it reaches a final volume of 2 L.

- (a) Draw a  $PV$  diagram for this process to indicate the behavior corresponding to the subsystems A and B.
- (b) With this information, calculate  $\Delta U$  and  $\Delta H$  for A, B, the surroundings and the universe. In addition, calculate the final pressures and temperatures of A and B.

Process A is some kind of expansion; & Process B is an Adiabatic compression.  
The pressures are always the same, since the process is reversible. -> The system is always in a state of equilibrium.

Problem 4 - For B

Initial Temperature

$$T_{i_B} = \frac{P_{i_B} V_{i_B} n^{-1} R^{-1}}{(1atm)(5L)}$$
$$T_{i_B} = \frac{(0.5mol)(0.08206atmLK^{-1}mol^{-1})}{T_{i_B} = 121.862K}$$

Final pressure

As B is dealing with an monoatomic gas,  $C_v = \frac{3}{2}R$  &  $\gamma = \frac{5}{3}$

$$P_{i_B} V_{i_B}^{\gamma} = P_{f_B} V_{f_B}^{\gamma}$$
$$P_{f_B} = \frac{P_{i_B} V_{i_B}^{\gamma}}{V_{f_B}^{\gamma}}$$
$$P_{f_B} = \frac{(1atm)(5L)^{\frac{5}{3}}}{(2L)^{\frac{5}{3}}}$$
$$P_{f_B} = 4.605atm = 466602Pa$$

Final Temperature

$$T_{f_B} = \frac{P_{f_B} V_{f_B}}{nR}$$
$$T_{f_B} = \frac{(4.605atm)(2L)}{(0.5mol)(0.08206atmLK^{-1}mol^{-1})}$$
$$T_{f_B} = 224.4699K$$

Internal energy

$$\Delta U_B = Q_B - W_B$$

where  $Q_B = 0$ , and for adiabatic processes,

$$W_B = \frac{P_{f_B} V_{f_B} - P_{i_B} V_{i_B}}{\gamma - 1}$$
$$W_B = \frac{(4.605atm)(2L) - (1atm)(5L)}{\frac{5}{3} - 1}$$
$$W_B = 6.315atmL = 639.709J$$
$$\Delta U_B = -639.709J$$

Entropy for adiabatic processes is:

$$\Delta S_B = 0JK^{-1}$$

Problem 4 - For A

Initial temperature

$$T_{i_A} = T_{i_B} = 121.862K$$

Final pressure

$$P_{f_A} = P_{f_B} = 4.605atm = 466602Pa$$

Final temperature

$$T_{f_A} = \frac{P_{f_A} V_{f_A}}{nR}$$
$$T_{f_A} = \frac{(4.605atm)(8L)}{(0.5mol)(0.08206atmLK^{-1}mol^{-1})}$$
$$T_{f_A} = 897.8796K$$

Internal energy

$$\Delta U_A = nC_v \Delta T_A$$
$$\Delta U_A = (0.5mol) \left( \frac{3R}{2} \right) (897.8796K - 121.862K)$$
$$\Delta U_A = 4839.127J$$

Entropy

$$dU = TdS - PdV$$
$$dS = \frac{1}{T}dU + \frac{P}{T}dV$$
$$\Delta S_A = \frac{1}{T_{f_A}} \Delta U_A + \frac{P_{f_A}}{T_{f_A}} (V_{f_A} - V_{i_A})$$
$$\Delta S_A = \frac{1}{897.8796K} (4839.127J) + \frac{466602Pa}{897.8796K} (8L - 5L)$$

$$\Delta S_A = 6.948JK^{-1}$$

Problem 4 - For the Surroundings and the Universe

Internal Energy

$$\begin{aligned}\Delta U_{universe} &= 0J \\ \Delta U_{universe} &= \Delta U_A + \Delta U_B + \Delta U_{surroundings} \\ \Delta U_{surroundings} &= -\Delta U_A - \Delta U_B \\ \Delta U_{surroundings} &= -4839.127J - (-639.709J) \\ \Delta U_{surroundings} &= -4199.418J\end{aligned}$$

Entropy

$$\Delta S_{universe} = 0JK^{-1}$$

$$\begin{aligned}\Delta S_{universe} &= \Delta S_A + \Delta S_B + \Delta S_{surroundings} \\ \Delta S_{surroundings} &= -\Delta S_A - \Delta S_B \\ \Delta S_{surroundings} &= -6.948JK^{-1} - 0JK^{-1}\end{aligned}$$

$$\Delta S_{surroundings} = -6.948JK^{-1}$$



```
In [6]: # Function to compute the "next" pressure value
def P_p_(Pi, Vi, Vf, gamma):
    return (Pi*Vi**gamma)/(Vf**gamma);

def P_(Tf, n, R, Vf):
    return (Tf*n*R)/(Vf);

# Draw the plot's workspace
scale = 6;
plt.subplots(figsize=(3*scale, 2*scale))

# For P_B
Pi = 1 #atm
Vi = 5 #L
Vf = 2 #L
gamma = 5/3
V = np.linspace(Vi,Vf,1000);
P_B = P_p_(Pi, Vi, V, gamma)
plt.plot(V, P_B, '-', linewidth=3, label='B');

# For P_A
Pi = 1 #atm
Vi = 5 #L
Vf = 8 #L
gamma = 1
V = np.linspace(Vi,Vf,1000);
P_A = P_p_(Pi, Vi, V, gamma)
plt.plot(V, P_B, '-', linewidth=3, label='A');

# For Temps
n = 0.5 #mol
R = 0.08206 #atm L / K mol

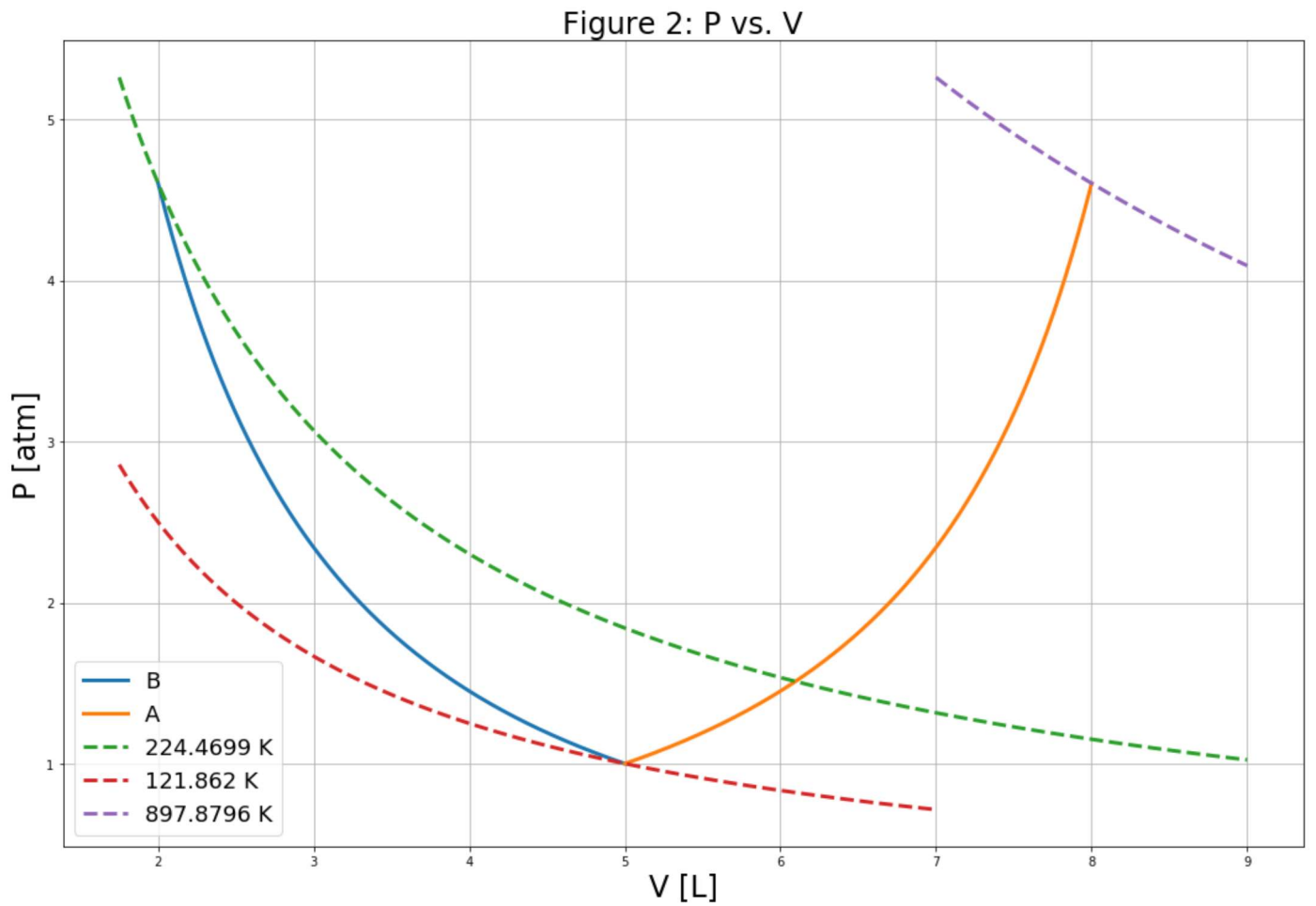
Tf = 224.4699 #K
Vi = 1.75 #L
Vf = 9 #L
V = np.linspace(Vi,Vf,1000);
P = P_(Tf, n, R, V)
plt.plot(V, P, '--', linewidth=3, label='224.4699 K');

Tf = 121.862 #K
Vi = 1.75 #L
Vf = 7 #L
V = np.linspace(Vi,Vf,1000);
P = P_(Tf, n, R, V)
plt.plot(V, P, '--', linewidth=3, label='121.862 K');

Tf = 897.8796 #K
Vi = 7 #L
Vf = 9 #L
V = np.linspace(Vi,Vf,1000);
P = P_(Tf, n, R, V)
plt.plot(V, P, '--', linewidth=3, label='897.8796 K');

plt.xlabel('V [L]', fontsize=24);
plt.ylabel('P [atm]', fontsize=24);
plt.title("Figure 2: P vs. V", size=24)
plt.legend(prop={'size': 18})
plt.grid('on')
display(plt);
```

<module 'matplotlib.pyplot' from 'C:\\Users\\oskat\\Anaconda3\\lib\\site-packages\\matplotlib\\pyplot.py'>



## Exercise 5

```
In [12]: display(Image(filename='./directions/5.jpg'))
```

5. Calculate the entropy change for a mole of a perfect diatomic gas when it expands isothermally and reversibly from a volume of 0.3 L to 2.4 L at a temperature of 298 K. What would be the change in entropy if it is considered now a van der Waals diatomic gas for which  $a = 6.26 \text{ atm L}^2 \text{ mol}^{-2}$  and  $b = 0.052 \text{ L mol}^{-1}$ ?

For Isothermic Processes,

$$ds = \frac{P}{T}dV = nR\frac{dV}{V}$$
$$\Delta S = nR\ln\left(\frac{V_f}{V_i}\right)$$
$$\Delta S = (1\text{mol})(8.314\text{JK}^{-1}\text{mol}^{-1})\ln\left(\frac{2.4\text{L}}{0.3\text{L}}\right)$$

$$\Delta S = 17.289\text{JK}^{-1}$$

Considering a van der Waals diatomic gas,

$$\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$$
$$P = \frac{nRT}{V - nb} - \frac{n^2a}{V^2}$$

Let's use the Maxwell relationship approach to determine the partial derivative of entropy.

$$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V = \frac{nR}{V - nb}$$
$$dS = \frac{nR}{V - nb}dV$$
$$\Delta S = \int_{V_i}^{V_f} \frac{nR}{V - nb} dV$$
$$\Delta S = nR [\ln(-nb + V_f) - \ln(-nb + V_i)]$$
$$\Delta S = (1\text{mol})(8.314\text{JK}^{-1}\text{mol}^{-1}) [\ln(-(1\text{mol})(0.052\text{Lmol}_{-1}) + 2.4\text{L}) - \ln(-(1\text{mol})(0.052\text{Lmol}_{-1}) + (0.3\text{L}))]$$

$$\Delta S = 18.69\text{JK}^{-1}$$

Exercise 6

In [13]:

display(Image(filename='./directions/6.jpg'))

6. What will be the entropy change of 1 mol of liquid benzene if at 20 °C it is compressed from 1 atm to 100atm? The coefficient of thermal expansion for benzene at this temperature is  $12.4 \times 10^{-4} \text{ K}^{-1}$ .

$$\begin{aligned}\rho_{benzene} &= 874g/L \\ M_{benzene} &= 78.11g/mol \\ \alpha_{benzene} &= 12.4 \times 10^{-4} K^{-1} \\ C_{V_{benzene}} &= 92.8 JK_{-1} mol_{-1}\end{aligned}$$

Volume of 1 mol of liquid benzene:

$$\begin{aligned}\frac{874g}{1L} &= \frac{78.11g}{V_{benzene}} \\ V_{benzene} &= 0.0894L\end{aligned}$$

Let's use the Maxwell relationship approach to determine the partial derivative of entropy.

$$\left(\frac{\partial S}{\partial P}_T\right) = -\left(\frac{\partial V}{\partial T}_P\right) = -V\alpha$$

Knowing that  $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}_P\right)$

$$\begin{aligned}dS &= -\alpha V dP \\ \Delta S &= -\alpha V (P_f - P_i) \\ \Delta S &= -(12.4 \times 10^{-4} K^{-1})(0.0894L)(100atm - 1atm)\end{aligned}$$

$$\begin{aligned}\Delta S &= -0.01010atmLLK^{-1} \\ \Delta S &= -1.112016JK^{-1}\end{aligned}$$

Exercise 7

In [14]:

display(Image(filename='./directions/7.jpg'))

7. Calculate the change in the enthalpy and the change in entropy when 1 mole of SiC is heated from 25 °C to 1000 °C. The constant-pressure molar heat capacity of SiC varies with temperature as

$$\overline{C}_P = 50.79 + 1.97 \times 10^{-3} T - 4.92 \times 10^6 T^{-2} + 8.20 \times 10^8 T^{-3} \quad \text{J/mol K}$$

$$\Delta S_{SiC} = \int_{T_i}^{T_f} \frac{\delta q_{rev}}{T} dT = \int_{T_i}^{T_f} \frac{\delta q_P}{T} dT = \int_{25^\circ\text{C}}^{1000^\circ\text{C}} \frac{nC_{p_{SiC}}}{T} dT$$

As  $n = 1mol$ ,

$$\begin{aligned}\Delta S_{SiC} &= \int_{25^\circ\text{C}}^{1000^\circ\text{C}} \frac{50.79 + \frac{1.97T}{10^3} - \frac{4.92 \times 10^6}{T^2} + \frac{8.2 \times 10^8}{T^3}}{T} dT \\ \Delta S_{SiC} &= \int_{25^\circ\text{C}}^{1000^\circ\text{C}} \frac{0.00197T^4 + 50.79T^3 - 4.92 \times 10^6 T + 8.2 \times 10^8}{T^4} dT\end{aligned}$$

$$\Delta S_{SiC} = \left[ \frac{2.73333 \times 10^8}{T^3} + \frac{2.46 \times 10^6}{T^2} + 0.00197T + 50.79\ln(T) \right]_{T_i=25^\circ\text{C}=298.2K}^{T_f=1000^\circ\text{C}=1273K}$$

$$\Delta S_{SiC} = (366.998 - 307.333)JK^{-1} = 59.6644JK^{-1}$$

$$\begin{aligned}\Delta H_{SiC} &= \int_{T_i}^{T_f} nC_{p_{SiC}} dT \\ \Delta H_{SiC} &= \int_{T_i=25^\circ\text{C}=298.2K}^{T_f=1000^\circ\text{C}=1273K} 50.79 + \frac{1.97T}{10^3} - \frac{4.92 \times 10^6}{T^2} + \frac{8.2 \times 10^8}{T^3} dT \\ \Delta H_{SiC} &= \left[ -\frac{4.1 \times 10^8}{T^2} + \frac{4.92 \times 10^6}{T} + 50.79T + 0.000985T^2 \right]_{T_i=298.2K}^{T_f=1273K}\end{aligned}$$

$$\Delta H_{SiC} = (69863.8 - 27121.4)J = 42742.3J$$

In [ ]: