Instructions: Closed Book; Answer all questions; Please write clearly and in an organized manner
Use SI units throughout

R_u = 8.314 kJ/kmol·K = 0.08314 bar·m^3/kmol·K
1 kJ/kg = 1000 m^2/s^2
1 kJ = 1 kPa m^3
1 kW = 1 kJ/s

Student Name	
Student ID	
Discussion Section	

Problem	Grade
1	/10
2	/10
3	/40
4	/40
TOTAL	/100

Problem 1 (10 points)

For a pure substance $dh = c_p dT + \left[v - T\left(\frac{\partial v}{\partial T}\right)_P \right] dP$

For an ideal gas, this relationship implies which of the following. Circle the best answer.

a) Enthalpy depends on both temperature and pressure
b) Both terms on the right side are nonzero and important
c) Enthalpy is a function of pressure
d) Enthalpy is only a function of temperature

Problem 2 (10 points)

For a reversible, closed system, which statement below correctly describes the path dependence of change in enthalpy and work? Read each answer carefully and circle the best answer.

(a) Both the change in enthalpy and the work depend on the path taken. Both are path **dependent**.
(b) Neither the change in enthalpy nor the work depends on the path taken. Both are path **independent**.
(c) The change in enthalpy does not depend on the path taken and, therefore, is path **independent**. The work depends on the path taken and, therefore, is path **dependent**.
(d) The change in enthalpy depends on the path taken and, therefore, is path **dependent**. The work does not depend on the path taken and, therefore, is path **independent**.

Problem 3 (40 points) (For this problem, DO NOT USE MATLAB; show all your work and justify every step of your calculations.)

1 kg of air, initially at 500 kPa and 350 K, and 3 kg of carbon dioxide (CO_2), initially at 200 kPa and 450 K, are confined to opposite sides of a well-insulated rigid container. The partition is free to move and allows conduction without energy storage in the partition itself. The air and carbon dioxide behave as ideal gases with constant specific heats,

Air	C_v = 0.726 kJ/kg-K,	R = 0.2870 kJ/kg-K,
Carbon dioxide	C_v = 0.750 kJ/kg-K,	R = 0.1889 kJ/kg-K

Neglect changes in potential and kinetic energies.

(a) Determine the final equilibrium temperature in K.
(b) Determine the final equilibrium pressure in kPa.

Problem 4 (40 points) (Use Matlab to find states, show all work and calculations; you may use `>>help state` to see the syntax.)

A device takes two streams of water and outputs a third stream at a specified pressure, as shown below. The first input has a mass flow rate of 2 kg/s, a temperature of 150 °C and a quality of 0.75; the second input is a saturated liquid with a pressure of 900 kPa and a mass flow rate of 1 kg/s. The device also has a shaft work input at a rate of 3500 kW. If the output stream is at 1MPa determine the temperature. Assume steady state and that there are no other work or heat interactions between the device and the surroundings; neglect any changes in the potential and kinetic energy of the streams.