ME 24-221
Thermodynamics I

First Mid-Term Examination
6 October 2000
Fall 2000
Instructor: J. Murthy
Open book, open notes
50 minutes
Total: 25 points
Problem 1: 5 points; Problem 2: 10 points; Problem 3: 10 points

1. A closed rigid vessel contains water at the critical point. It is cooled until it reaches a temperature of 100°C. Find the final quality.

2. Air is contained in a piston-cylinder assembly as shown in Figure 1. Initially, the piston is positioned as shown and is free to move. The external atmospheric pressure and the weight of the piston are held constant. The initial pressure of the air is 100 kPa, the initial volume is 1L, and the initial temperature is 300 K. The air is heated and causes the piston to move until it hits the stops. At this point, the volume of the air is 2L. It is heated further until its temperature reaches 900 K.

   (a) What is the temperature at the point when the piston just hits the stops?

   (b) What is the pressure when its temperature reaches 900 K?

   (c) What is the total work done in kJ?

   (d) Draw the process on a PV diagram.

   You may assume that air is a perfect gas.

3. An insulated rigid container is divided into two parts by an <u>un-insulated</u> rigid divider, as shown in Figure 2. Sub-system A initially contains 0.1 kg of water at 200°C and a pressure of 100 kPa. Sub-system B initially contains 0.2 kg of water at temperature of 80°C and a quality of 0.8. The sub-systems are allowed to exchange heat until sub-system A reaches a final temperature of 150°C and a final pressure of 50 kPA and sub-system B has reached a final temperature of 90°C.

   (a) Write the first law of thermodynamics for the total system consisting of A and B. Hence write the first law for each of the sub-systems A and B.

   (b) Find the heat transfer $({}_1Q_2)_A$ to sub-system A in kJ.

   (c) Find the final quality of the water in sub-system B.

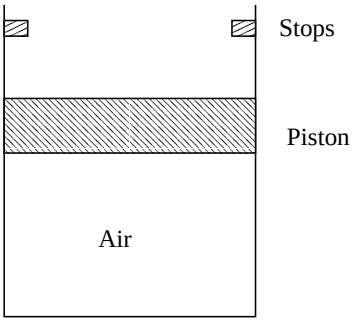

Figure 1: Schematic for Problem 2

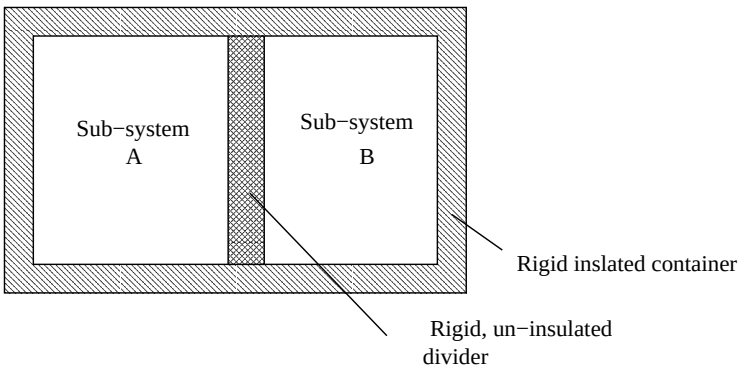

Figure 2: Schematic for Problem 3