Thermodynamics 084213 – Winter 2020 – HW8

1) Air at ambient conditions (100 kPa, 20◦C) is contained in a piston/cylinder setup. The volume is 300 mL. A reversible polytropic compression process with exponent n = 1.2 is performed to 800 kPa. Afterwards, the system is expanded back to the initial pressure in an isentropic process. Ideal gas can be assumed.

a. Show in P–v and T–s diagrams the two processes.

b. What is the final temperature and the net-work?

2) A constant pressure heating process at 400 kPa occurs for water from 150°C to 1200°C. Find the specific entropy change by using:

a) Steam tables

b) Ideal gas water Table A.8

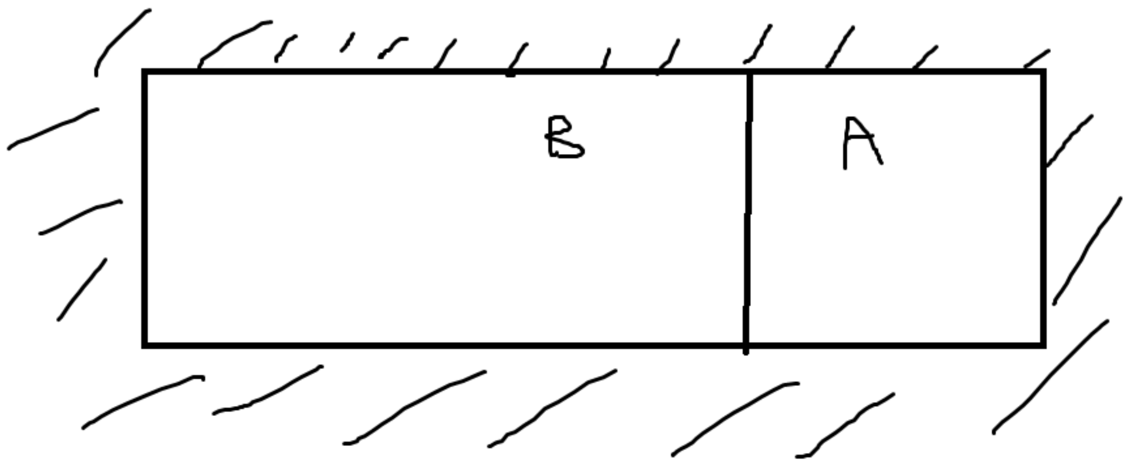
c) The specific heat from A.5, assumed constant.

d) Explain differences between the three calculations and reasons for different results (if any).

3) A 20L cylinder contains initially water at 3MPa, with 50% quality. The piston is movable. 600 kJ of heat are received from a reservoir at 300°C, and the cylinder expands. The final pressure is 1.2 MPa. The work measured in the expansion process is 124 kJ. Is it possible?

4) Ammonia at -20◦C and 50 kPa is initially contained inside a piston/ cylinder setup. The cylinder is placed over a hot plate held at 200◦C, and the system is heated at constant pressure. Find the amount of heat transferred to the ammonia and the total entropy generation in the process. The mass of the ammonia is 2.5 kg, and the heating is performed until the ammonia reaches a temperature of 50◦C.

5) An insulated and rigid tank contains CO_2 in two separate volumes A,B, separated by a rigid barrier.



In volume A we have 1 kg of CO_2 at 227°C and 100 kPa. In volume B we have 2 kg of CO_2 at 1727°C 200 kPa. The rigid barrier is suddenly removed, and the system reaches equilibrium. Ideal gas can be assumed.

a. What is the final temperature and pressure?
b. What is the entropy generation in the process? Use the most accurate method learned in the TA session.

6) A new invention is being proposed. The device operates in steady-state, has no heat transfer with the surroundings, and no work is done. A flow of air is provided to the inlet of the device at a temperature of 20°C and pressure of 5.1 atm. The air is split into two streams: a high temperature stream at 80°C, containing 40% of the mass flux, and a low temperature stream at -20°C, containing 60% of the mass flux. Both exits are at a pressure of 1 atm. Determine if this invention is possible. You can assume air behaves as an ideal gas with a constant specific heat, and ΔKE=0, ΔPE=0.