HW5 (Thermodynamics I)

Due: 2021/06/03

1. Water at 100 kPa, 150^{O}C receives 75 kJ/kg in a reversible process by heat transfer. Which process changes s the most: constant T, constant v or constant P?

2. An ideal gas goes through a constant T reversible heat addition process. How do the properties (v, u, h, s, P) change (up, down or constant)?

3. Carbon dioxide is compressed to a smaller volume in a polytropic process with n = 1.2. How do the properties (u, h, s, P, T) change (up, down or constant)?

4. A reversible process in a piston/cylinder is shown in Fig. P6.8. Indicate the storage change $u_2 - u_1$ and transfers ${}_1w_2$ and ${}_1q_2$ as positive, zero, or negative.

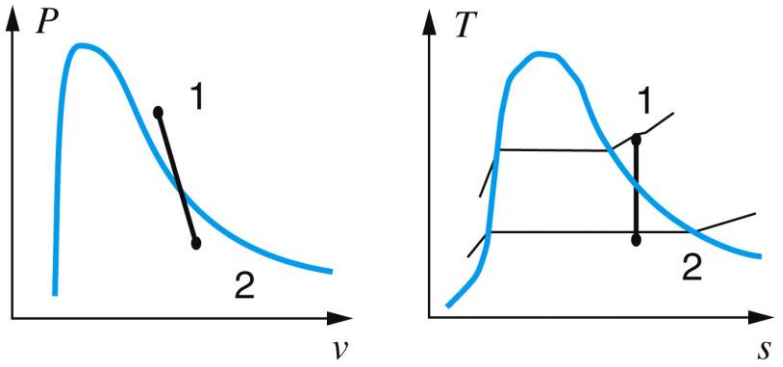

Figure P6.8

5. A heat engine receives 6 kW from a 250^{O}C source and rejects heat at 30^{O}C. Examine each of three cases with respect to the inequality of Clausius.
a. $\dot{W}$ = 6 kW
b. $\dot{W}$ = 0 kW
c. Carnot cycle

6. Find the missing properties of P, v, s and x for ammonia (NH_3) at

a. T = 65°C, P = 600 kPa

b. T = 20°C, u = 800 kJ/kg

c. T = 50°C, v = 0.1185 m^3/kg

7. Two kg water at 400 kPa with a quality of 25% has its temperature raised 20^{O}C in a constant pressure process. What is the change in entropy?

8. Water is used as the working fluid in a Carnot cycle heat engine, where it changes from saturated liquid to saturated vapor at 200°C as heat is added. Heat is rejected in a constant pressure process (also constant T) at 20 kPa. The heat engine powers a Carnot cycle refrigerator that operates between –15°C and +20°C. Find the heat added to the water per kg water. How much heat should be added to the water in the heat engine so the refrigerator can remove 1 kJ from the cold space?

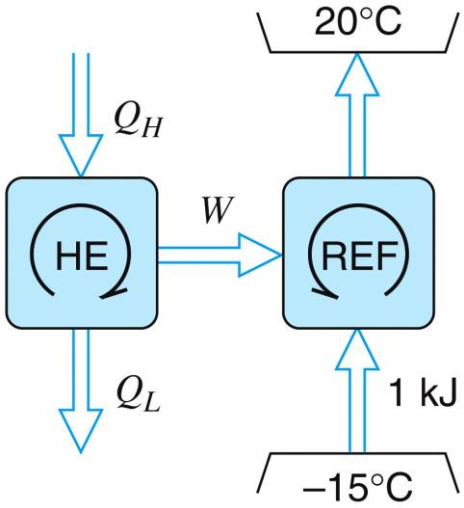

Figure P6.38

9. A piston/cylinder contains 0.5 kg of water at 200 kPa, 300°C, and it now cools to 150°C in an isobaric process. The heat goes into a heat engine that rejects heat to the ambient at 25°C (shown below), and the whole process is assumed to be reversible. Find the heat transfer out of the water and the work given out by the heat engine.

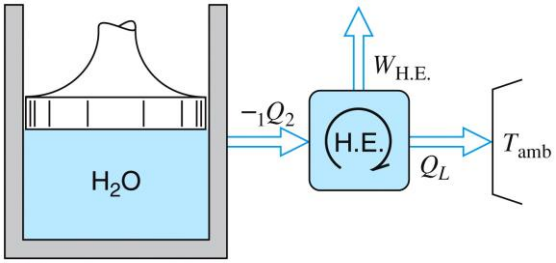

Figure P6.46