CM 3230
Fall 2011
Exam 1 (Take 2)

Name ____

1. (25 pts) 10 moles of an ideal gas having heat capacity $C_P = 3R/2$ is contained in a cylinder having negligible heat capacity and compressed irreversibly by a constant external pressure until its pressure reaches the same value as the external pressure $P_{ext} = 2.5\ bar$s, while the temperature settles to the constant surrounding bath temperature. The gas was initially at $T = 25°C$ and $P = 2\ bars$. The change in entropy of the gas from initial to final condition is zero. Determine the change in entropy of the surroundings ΔS_{surr} (in J/K).

2. (25 pts) Three different gases (all behaving as ideal gases) initially at the same temperature are all contained in one rigid, insulated, closed container (of negligible heat capacity) but are separated from each other by impermeable rigid membranes. The initial pressure of each gas is given in Table 1 below. After all the membranes were broken, the gases were completely mixed and settled to a common temperature. Determine the change in entropy of the system ΔS_{sys} (in J/K).

Table 1. Data for problem 2.

Gas	Moles	$C_P\left(\frac{J}{mol\ °C}\right)$	Initial Pressure
A	10	$3R/2$	$1\ bar$
B	10	$7R/5$	$1.3\ bar$
C	20	$5R/4$	$2\ bar$

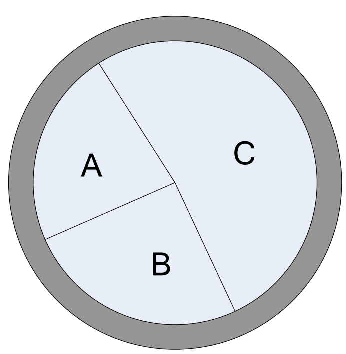

Figure 1. A system with three ideal gases.

3. (25 pts) 20 moles of ideal gas with heat capacity $C_P = 3R/2$ is used in a Carnot cycle shown in Figure 2, i.e. isothermal expansion from point 1 to 2, followed by an adiabatic expansion to point 3, an isothermal compression to point 4 then an adiabatic compression back to point 1. Suppose that at point 3, we have $T_3 = 200\ K$ and $P_3 = 1\ bar$. Find the volume expansion ratio from point 2 to 3, i.e. (v_3/v_2) to obtain a Carnot efficiency of 60%.

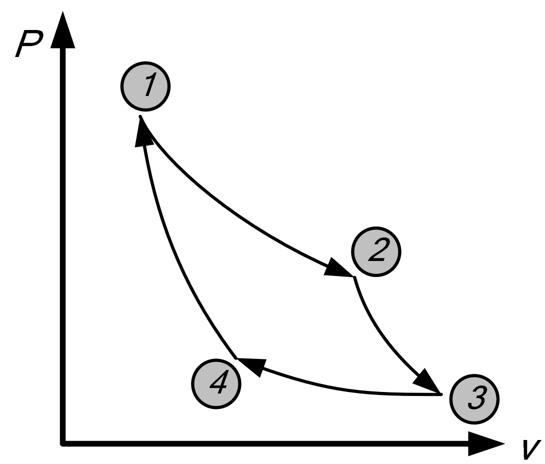

Figure 2. Carnot cycle.

4. (25 pts) Steam at $T_1 = 700°C$ and $P_1 = 4\ MPa$ flowing at a rate of 100 kg/s is expanded isentropically through a turbine and exits at $P_2 = 40\ kPa$. It then goes through a condenser and exits at point 3 with a steam quality of $x_3 = 0.20$. In the condenser, the cooling liquid has a heat capacity $C_v = 50\ R$, a molecular weight $MW = 130\ kg/kmol$, and enters at point 4 with $T_4 = 60°C$ and exits at point 5 with $T_5 = 68°C$. Determine the mass flow rate of the cooling liquid.

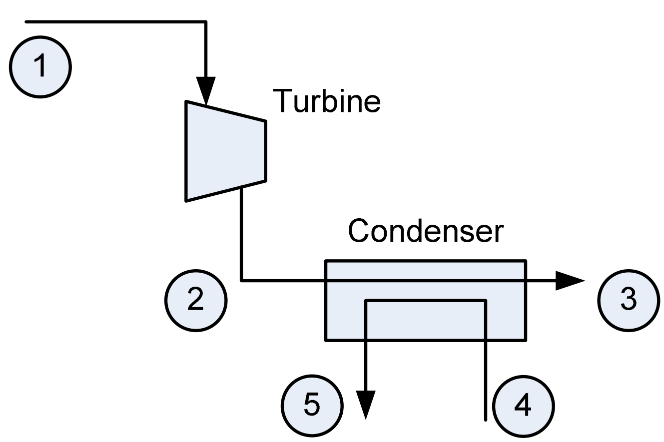

Figure 3. A turbine followed by a condenser system.