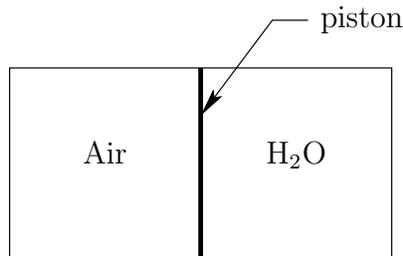


ME 227.3 Thermodynamics I
Department of Mechanical Engineering
University of Saskatchewan
Final Examination, 9:00am December 10, 2004

- (10) 1. Define the following terms.
- (a) Carnot cycle
 - (b) Ideal gas
 - (c) Reheater
 - (d) Subcooled liquid
 - (e) Cycle
- (10) 2. An inventor claims to have developed a refrigerator that produces a refrigeration effect of 20 kW while rejecting heat at a rate of 26 kW when operating between temperatures of -30°C and 30°C . Is this possible? [**Answer:** Yes]
- (20) 3. A closed, uninsulated vessel with a total volume of 0.1 m^3 is initially divided into two equal volumes by a piston. One side of the vessel contains air ($R = 0.287\text{ kJ}/(\text{kg} \cdot \text{K})$) at 293 K and 100 kPa. The other side contains water at 200 kPa and a quality of 50%. The piston is allowed to move and the entire vessel comes into thermal equilibrium with the surroundings that are at 293 K (20°C). What is the heat transfer between the vessel and the surroundings? [**Answer:** -162 kJ]



- (20) 4. An adiabatic nozzle operates with inlet conditions of 1 MPa, 1000 K, and negligible velocity. It discharges to a region where the pressure is 10 kPa. The process can be described by $Pv^{1.2} = \text{constant}$. The substance is air with $R = 0.287\text{ kJ}/(\text{kg} \cdot \text{K})$. What is the velocity at the exit of the nozzle? What is the isentropic efficiency of the nozzle? [**Answer:** 1077 m/s]
- (20) 5. A vapour compression refrigeration system uses R134a as its working fluid and operates between 0.6 bar and 7 bar. The coefficient of performance is 2.6 and the isentropic efficiency of the compressor is 87%. If the compressor inlet is superheated by 5°C , what is the temperature at the exit of the condenser? [**Answer:** 17.6°C] What can you say about the temperature of the region to which this system is rejecting heat?
- (20) 6. An ideal Rankine cycle operates with a closed feedwater heater. The steam generator pressure is 100 bar and the condenser pressure is 10 kPa. 7.6% of the flow entering the first turbine is extracted. The extracted steam leaves the feedwater heater as a saturated liquid. The exit of the condenser is a saturated liquid. The quality at the entrance of the condenser is 84%. The feedwater temperature increases by 40°C as it passes through the feedwater heater. Calculate the net power output if the flow rate from the steam generator is 400 kg/s. [**Answer:** 558.7 MW]