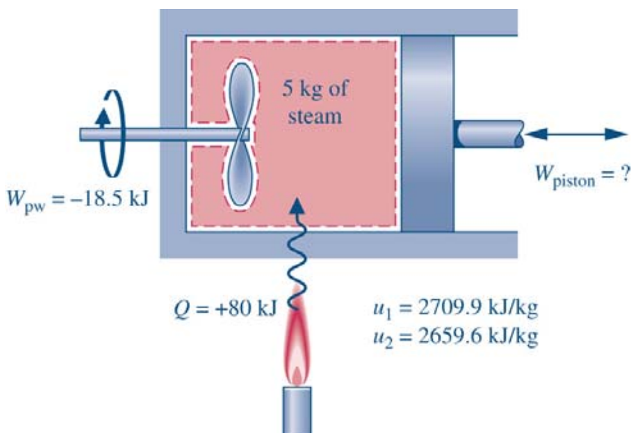
HOMEWORK 2

Handed out: Monday, 3 September 2007 Due: Monday, 10 September 2007, 5 pm

Notes:

1. Drop HW off in the designated homework box in Upson 123
2. Be sure that you **indicate your recitation section (and your name!)** on the top of the first page of your HW. **We will not accept late homework**.
3. Homeworks will be returned in your recitation. The TAs have been instructed to keep your HW **for only one extra week** in case you miss a recitation.
4. Problems with (*) refer to problems to be discussed in your recitation. We strongly advice you to try to solve these problems before you attend your recitation. Note that you should submit solutions to ALL problems in this HW including those indicated with a (*).

1. (**Using Energy Balance – Chapter 2**) 5 kg of steam contained within a piston-cylinder assembly undergoes an expansion from state 1, where the specific internal energy is u_1=2709.9 kJ/kg, to state 2, where u_2=2659.6 kJ/Kgr. During the process, there is heat transfer to the steam with a magnitude of 80 kJ. Also the paddle wheel transfers energy to the steam by work in the amount of 18.5kJ. There is no significant change in the kinetic or potential energy of the steam. Determine the energy transfer by work from the steam to the piston during the process, in kJ.



2. (**Using energy balance – Chapter 2**) Two kilograms of air is contained in a rigid well insulated tank with a volume of 0.6 m^3. The tank is fitted with a paddle wheel that transfers energy to the air at a constant rate of 10W for 1 hr. If no changes in kinetic or potential energy occur, determine

a) the specific volume at the final state, in m^3/kg
b) the energy transfer by work in kJ
c) the change in specific internal energy of the air in kJ/kg

3. (**Cycles – Chapter 2**) A power cycle receives energy by heat transfer from the combustion of fuel and develops power at a net rate of 150 MW. The thermal efficiency of the cycle is 40%.

a) Determine the net rate at which the cycle receives energy by heat transfer, in MW.
b) For 8000 hours of operation annually, determine the net work output in kW-h per year
c) Evaluate the net work output at $0.08 per kW-h, determine the value of net work, in $ per year

4. (**Using Energy Balance – Chapter 2**) Air is contained in a vertical piston-cylinder assembly by a piston of mass 50kg and having a face area of $0.01 m^2$. The mass of the air is 5g, and initially air occupies a volume of 5 liters. The atmosphere exerts a pressure of 100 kPa on top of the piston. The volume of the air slowly decreases to $0.002 m^3$ as the specific internal energy of the air decreases by 260 kJ/kg.
a) Draw a P-V diagram to illustrate the process
b) Neglecting friction between the piston and the cylinder wall, determine the heat transfer to the air in kJ.

5. (**Using p-v-T data – Chapter 3**) Ammonia undergoes an isothermal process from an initial state at $T_1 = 80^oF$ and $v_1 = 10\ ft^3/lb$ to saturated vapor. Determine the initial and final pressures in lbf/in^2 and sketch the process on T-v and p-v diagrams.

6. (**Ideal gas model and compressibility data, Chapter 3**) Determine the temperature, in K, of oxygen (O_2) at 250 bar and a specific volume of 0.003 m^3/kg using generalized compressibility data and compare with the value obtained using the ideal gas model.

7. (**Energy balance and ideal gas model – Chapter 3**) Ammonia is contained in a rigid, well insulated container. The initial pressure is 20 lbf/in^2, the mass is 0.12 lb, and the volume is 2 ft^3. The gas is stirred by a paddle wheel, resulting in an energy transfer to the ammonia of magnitude 20 Btu. Assuming the ideal gas model, determine the final temperature of the ammonia, in ^oR. Neglect kinetic and potential effects.

8. (**Energy balance – Chapter 3**) (*) A two phase liquid-vapor mixture of H_2O is initially at 1.0 MPa with a quality of 90 %, is contained in a rigid, well insulated tank. The mass of H_2O is 2 kg. An electric resistance heater in the tank transfers energy to the water at a constant rate of 60 W for 1.95 h. Determine the final temperature of the water in the tank, in ^0C and the final pressure in bar.