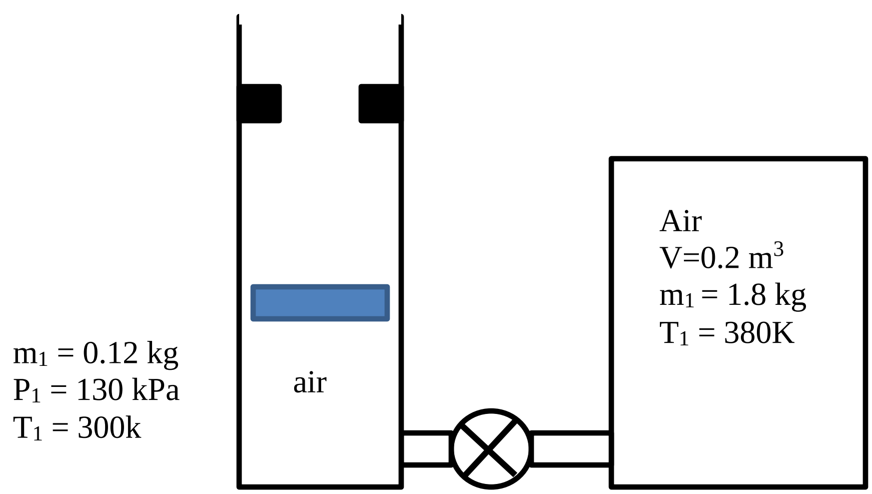
**In the oral exam, you will be asked to present your approach to the solution of the following problems. Because time will be limited, it is most important that you demonstrate that you know <u>how</u> to solve the problem, even if you don't have time to work through the detailed algebra to a final solution, and you should estimate any interpolated values from tables to save time. In preparing your notes, bear in mind that you will be asked to state and defend any assumptions you make.**

**Question 1 (33 points) E3FL16**

Air is contained in a rigid tank and in a piston/cylinder system below. Initially the tank, with a volume of 0.2 $m^3$, contains 1.8 kg of air at 380K, and the cylinder contains 0.12 kg of air at a pressure of 130 kPa and 300K, with the frictionless piston unconstrained, as shown. The entire system is well insulated. The valve is then opened and the air from the tank pushes the piston up to the stops in the cylinder, doubling the cylinder volume. Finally, all of the air equilibrates, reaching the same final temperature. Assume the air to have **<u>variable</u>** specific heats.

a) Find the initial pressure in the tank (kPa)
b) Find the work (kJ)
c) Find the final temperature of the air (K)
d) Find the final pressure (kPa)



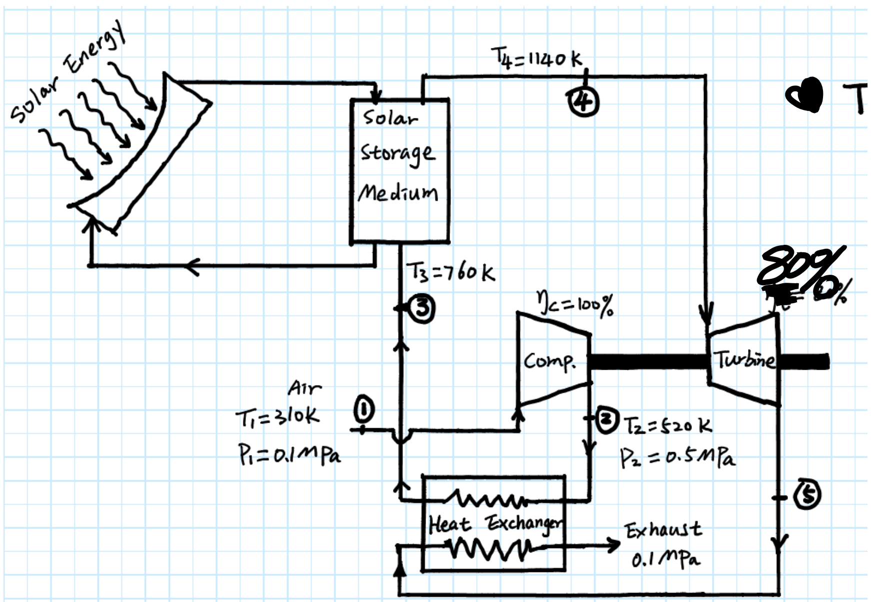
**Question 2 (33 points)**

1. (**30 points**) A gas turbine power plant uses solar energy as the source of heating. Operating data are given in the figure. Pressure drops can be neglected except across the compressor and turbine.

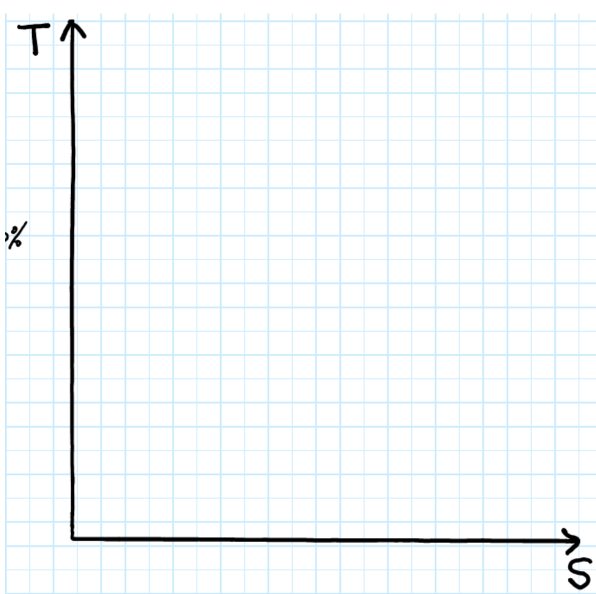
   (a) Please sketch this cycle on the T-s diagram, marking states 1~ 5 on your diagram. Determine the efficiency of the regenerator (heat exchanger in the figure).

   (b) Determine the thermal efficiency of the whole cycle

   (c) If a net power output of 500 kW is required, please find the air mass flow rate, in kg/s (Note: $W_{net}=W_{turbine}-W_{compressor}$)




**(a)**



**Question 3 (34 points) E2Sp16**

Two separate streams of $H_2O$ flow into a heat exchanger as shown below. Stream 1 (associated with **State 1**) has a mass flow rate of 3.0 $lb_m$/s and is at 400°F and 100 psia. Of Stream 1, 90% enters one side of the heat exchanger. Meanwhile 10% of Flow 1 is passed through a throttle valve to combine with Stream 3 (210°F) in a mixer at 50 psia. The combined flow (**State 4**) enters the other side of the heat exchanger as <u>**saturated liquid**</u>. The two flows do not mix within the heat exchanger. Exiting the heat exchanger, the flow at **State 5** is 350°F. Pressure drops through the heat exchanger, mixer and other tubing is negligible. Neglect the effect of pressure on the enthalpy of subcooled liquids. The entire system is adiabatic and all flows are steady.

a) What is the mass flow rate of Stream 3, into the mixer (lbm/s)?
b) What is temperature of State 6 (°F) and if saturated what is the quality?
c) What is the rate of entropy generation for the entire device (Btu/s °R)?