GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Fall Quarter 1995

Thermodynamics
EXAM AREA

Assigned Number **(DO NOT SIGN YOUR NAME)**

-- Please sign your name on the back of this page --

Thermodynamics Qualifier, Fall 1995

Problem 1:

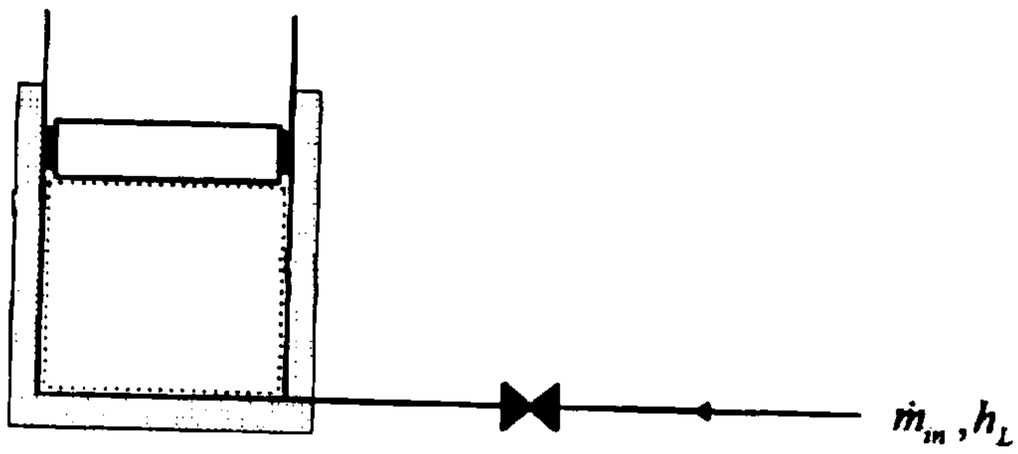
Air (an ideal gas with constant specific heats) at constant pipeline conditions of 2 bar and 300 K passes slowly through a valve into a well-insulated and frictionless piston cylinder assembly. The piston is weighted and also loaded by the ambient atmosphere so that a pressure of 1.5 bar in the cylinder is needed to support the piston. Initially, the cylinder is completely empty. At the end of the process the volume under the piston is 1 m^3.

Relate explicitly the final internal energy, u_2, in the cylinder to the line enthalpy, h_L, at 2 bar and 300K. Prove that u_2 either greater than, equal to, or less than h_L. [less than] [equal] [greater than]

Find the final temperature of the air in the cylinder, T_2 = _____ K

Evaluate the boundary work done during this process, W_b = _____ J

Evaluate the mass that enters the cylinder during the process, m = _____ kg



system sketch

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Fall Quarter 1995
PhD Qualifying Examination in Thermodynamics

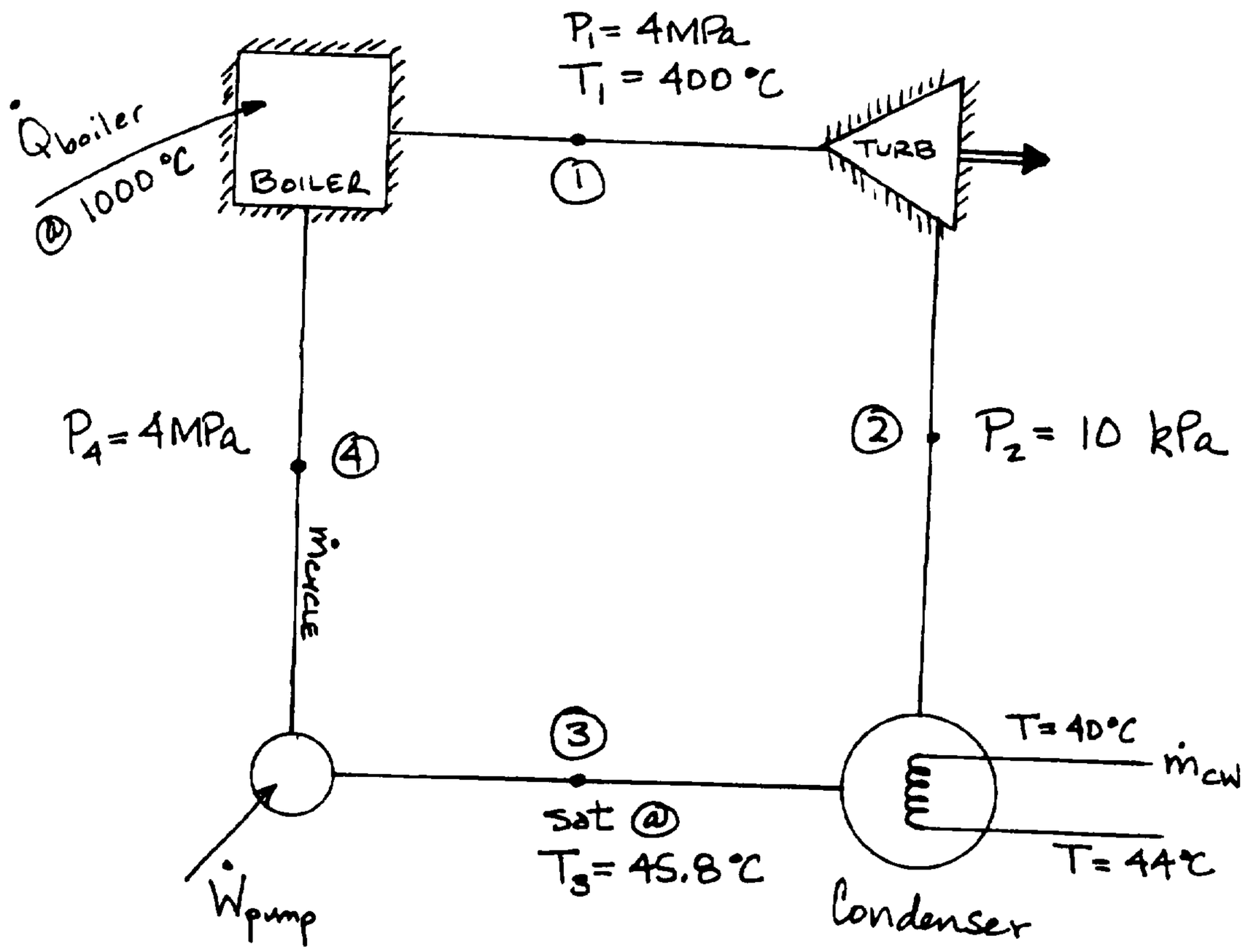
A steam power plant operates on a Rankine cycle with pressures and temperatures shown below. The efficiency of the turbine is 90% and the efficiency of the pump is 80%.

(a). Determine the thermal efficiency of this cycle.

(b). Compute the irreversibility in the boiler.

(c). Sketch this cycle on a T-S diagram

Hints: Make all necessary assumptions. Furthermore be careful NOT to over-analyze this system. These answers can be obtained fairly easily with relatively few computations. Show your work.



An R-12 reciprocating compressor is available that has four cylinders, each with a bore of 3.0 in. and stroke of 2.5 in., and is designed to operate at 1725 rpm. The compressor is being evaluated for an air conditioning application in which the condensing temperature would be 110F with 5F subcool and the evaporating temperature would be 40F with 10F superheat. Assuming the processes and equipment are ideal, estimate the:

(a) cooling capacity (Btu/hr)

(b) motor size required to drive the compressor (hp).

(c) cooling COP (cooling produced per unit of work input) of the system.