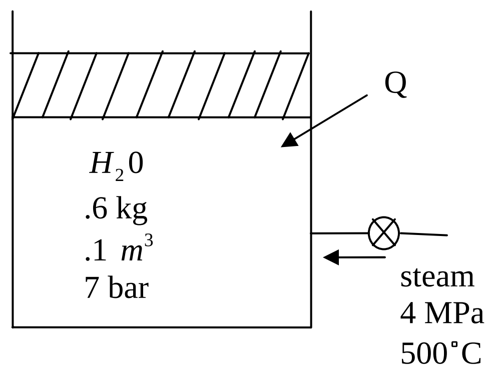
G. W. Woodruff School of Mechanical Engineering
Ph.D. Qualifying Exam, Fall 2007
Thermodynamics

Problem 1.
A piston-cylinder device initially contains 0.6 kg of $H_2 0$ with a volume of 0.1 m^3. The mass of the piston is such that it maintains a constant pressure of 7 bar. The cylinder is connected through a valve to a supply line that carries steam at 4 MPa and 500˚ C. The valve is opened and steam is allowed to flow slowly into the cylinder until the volume of the cylinder doubles and the temperature in the cylinder reaches 200˚C, at which point the valve is closed.

Determine

i. the mass of the steam that has entered, and

ii. the amount of heat transferred with the surroundings.



Problem 2

Two identical rocks are initially at 400 K. Cyclic machines are employed with the objective of cooling one (and only one) of the rocks to a temperature below 200 K in order to study its low-temperature behavior. The cyclic machineries can thermally interact with each rock, individually, as well as with the environment at 300 K. Under ideal conditions, what is the lowest temperature that could be reached for one of the rocks? [Hint: Assume constant specific heat.]

Please quantify your answer with a numerical accuracy better than 5 K. Clearly explain your reasoning and assumptions.

Problem 3

A regenerative vapor power cycle with an open feedwater heater is shown schematically in the figure below. Selected properties at the various locations are indicated in the table.

Find the thermal efficiency of the power cycle as a function of the mass fraction y bled into the open feedwater heater. Assume isentropic flow through the pumps. Also assume that the fluid at Location 6 is a liquid phase whose specific volume is equal to that of the saturated liquid phase at the given pressure.

Location	T(°C)	p (MPa)	h (kJ/kg)
1	480	8.0	
2		0.7	2832.8
3		0.008	2249.3
4		0.008	
5		0.7	
6		0.7	
7		8.0