Quiz 1

- This is a closed book exam.
- You have 90 minutes.
- Write your name and section number on both the question and answer sheets.
- It is recommended that you read the whole exam before you start solving.

Problem 1 (25 points)
Two kilograms of water are contained within a piston-cylinder arrangement. The piston is weightless and undergoes frictionless motion. See Figure 1. At the initial state, there are equal masses of liquid and vapor initially. The system is (process 1) slowly heated to a position where the piston is locked, and then (process 2) the system is cooled to the saturated vapor state at 50 °C. The atmospheric pressure is $p_a = 101.4$ kPa.
(a) Is process 1 isothermal, isobaric, or isochoric? Why? What about process 2? why?
(b) Draw the processes on a $p - v$ diagram, and
(c) Evaluate the work done during the process.

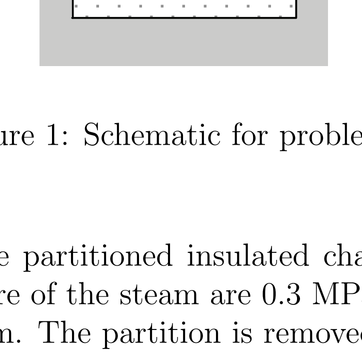

Figure 1: Schematic for problem 1.

Problem 2 (25 points)
Steam occupies one-half of the partitioned insulated chamber shown in Figure 2. The initial pressure and temperature of the steam are 0.3 MPa and 360 °C. The other half of the chamber contains a vacuum. The partition is removed, and the steam fills the entire volume at the end of the process. Determine the final temperature of the steam.

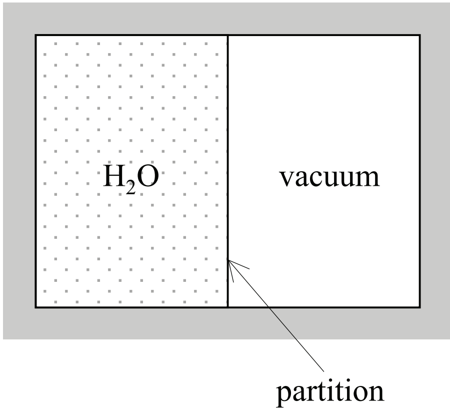

Figure 2: Schematic for problem 2.

Problem 3 (25 points)
The cylinder shown in Figure 3 contains 0.1 kg of water initially of volume 0.005 m^3. The spring touches the piston but exerts no force at this initial state. The piston, assumed frictionless, rises owing to heat transfer to the water until the water is in the saturated vapor state. The spring constant is 149.1 kN/m, and the piston area is 0.02 m^2, and the mass of the piston is 100 kg. The atmospheric pressure is $p_a = 100$ kPa.
(a) Determine the initial pressure and specific internal energy?
(b) Determine the final temperature and pressure.
(c) Evaluate the heat transfer

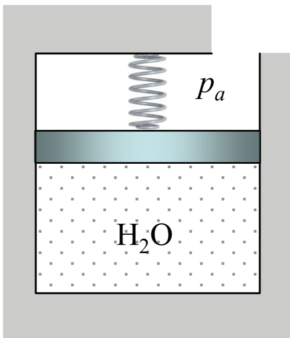

Figure 3: Schematic for problem 3.

Problem 4 (25 points)
Consider a copper sphere of mass m, radius R, constant specific heat c, initially (at time $t = 0$) of temperature T_0. The sphere is then placed in a bath of flowing hot water maintained at temperature $T_w > T_0$. At any time t, the temperature is assumed to be spatially uniform in the sphere. The convection heat transfer coefficient between the flowing water and the sphere is h. Assume that the work done in expanding the sphere is negligible and neglect changes in potential and kinetic energy.
(a) What is the internal energy of the sphere as a function of given quantities and the sphere temperature $T(t)$?
(b) What is the rate of heat gained by the sphere in terms of given quantities and $T(t)$?
(c) Using the first law of thermodynamics, find $T(t)$.