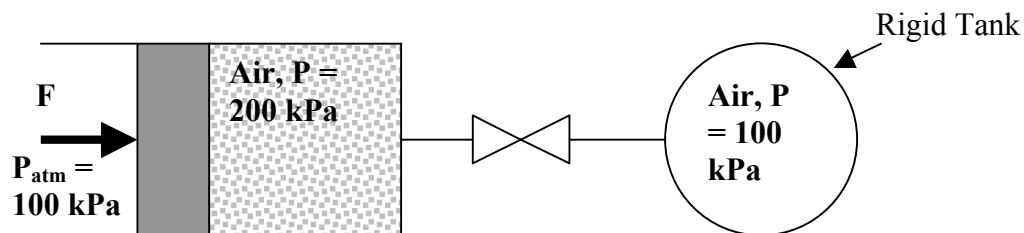


AREN 2110
Spring 2011

Homework #1: Due Friday, Jan 21, 6 PM

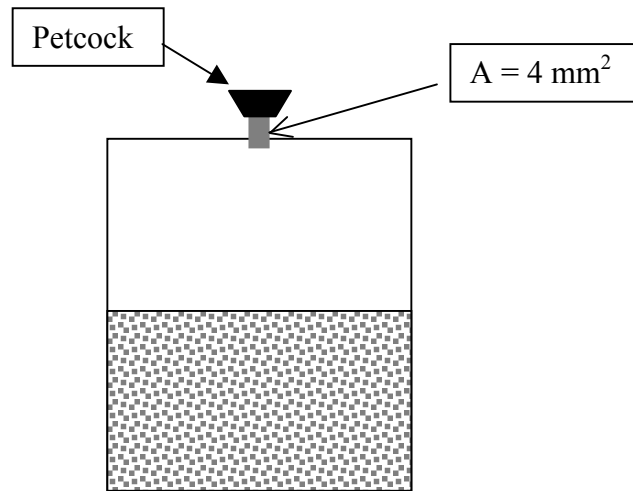
1. Systems and properties
 - a. A rigid wall tank contains argon, an ideal gas:
 - i. is the system open or closed?
 - ii. Specify two independent intensive thermodynamic properties that will determine the state of the system.
 - b. A piston-cylinder device contains a mixture of liquid water and water vapor.
 - i. Is the system open or closed?
 - ii. Specify two independent intensive properties which determine the state of the system
 - c. Steam expands as it passes through a turbine turning a generator coil.
 - i. Is the system open or closed?
 - ii. What are the possible energy interactions between the system and its surroundings?

2. The device below is used to raise the pressure of air in the rigid tank above the initial value of 100 kPa. When a force, F , is applied to the frictionless piston and the pressure in the cylinder exceeds 200 kPa, the one-way valve opens and air is pushed into the rigid tank. Assume that during this process, the air pressure in the cylinder remains at just barely above 200 kPa while the piston moves 0.2 m to the right. Cross sectional area of the piston (face) is 0.03 m^2 . Consider the system as the cylinder and the rigid tank.
 - a. Is this system open or closed? Justify your answer.
 - b. Calculate the work of the system, applying the sign convention.
 - c. Calculate the work of the surroundings, applying the sign convention.

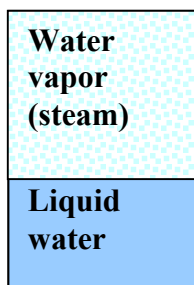


3. The barometer of a mountain hiker reads 930 mbars at the beginning of the hike and 780 mbars at the end. Neglecting the effect of altitude on local gravitational acceleration, determine the vertical distance climbed, assuming an average air density of 1.2 kg/m^3 .

4. A pressure cooker cooks food a lot faster than an ordinary pan by maintaining higher pressure and temperature inside. The lid of a pressure cooker is well sealed during cooking and steam can escape only through a small opening in the middle of the lid. The opening is covered by a metal petcock. The weight of the petcock prevents steam from escaping until it reaches a pressure inside high enough to lift the petcock slightly releasing just enough steam until the opening is closed again by the weight force of the petcock, thus maintaining constant pressure inside the cooker. What is the mass of the petcock required to maintain 100 kPa gage pressure in the cooker when the opening has a cross-sectional area of 4 mm^2 . Assume atmospheric pressure is 101 kPa. Include a free body diagram of the petcock in your solution showing all forces.



6. A closed rigid-wall tank with volume = 0.2 m^3 contains 1.5 kg wet steam including liquid water and vapor phases in equilibrium, as shown below. The specific volumes of the saturated liquid and vapor phases are $1.127 \times 10^{-3} \text{ m}^3/\text{kg}$ and $0.1943 \text{ m}^3/\text{kg}$, respectively. (Sketch is not to scale)
- Calculate the volume occupied by the vapor phase
 - Calculate the mass fraction of liquid water in the water-steam mixture in the system.



7. A CU engineering student is tired of the fact that the ice point of water in existing absolute temperature scales is an awkward number. She proposes a new absolute temperature scale, called the Buff scale, with the Buff degree symbolized by B. The ice point of water is 100 B.
- Is this a valid temperature scale? Why/Why not?
 - What is the boiling (steam) point of water in degrees B?
 - “Room temperature” is generally considered to be 20 degrees Celsius ($^{\circ}\text{C}$). Calculate room temperature in degrees B.