

CANKAYA UNIVERSITY
FACULTY OF ENGINEERING AND ARCHITECTURE
MECHANICAL ENGINEERING DEPARTMENT

ME 211 THERMODYNAMICS I

CHAPTER 1 EXAMPLES

1. When an object of mass 5 kg is suspended from a spring, the spring is observed to stretch by 8 cm. The deflection of the spring is related linearly to the weight of the suspended mass. What is the proportionality constant, in newton per cm, if $g = 9.81 \text{ m/s}^2$?

2. closed system consisting of 5 kg of a gas undergoes a process during which the relationship between pressure and specific volume is $p v^{1.3} = \text{constant}$. The process begins with $p_1 = 1 \text{ bar}$, $v_1 = 0.2 \text{ m}^3/\text{kg}$ and ends with $p_2 = 0.25 \text{ bar}$. Determine the final volume, in m^3 , and plot the process on a graph of pressure versus specific volume.

3. A gas contained within a piston-cylinder assembly undergoes a thermodynamic cycle consisting of three processes:

Process 1-2: Compression with $pV = \text{constant}$ from $p_1 = 1 \text{ bar}$, $V_1 = 1.0 \text{ m}^3$ to $V_2 = 0.2 \text{ m}^3$

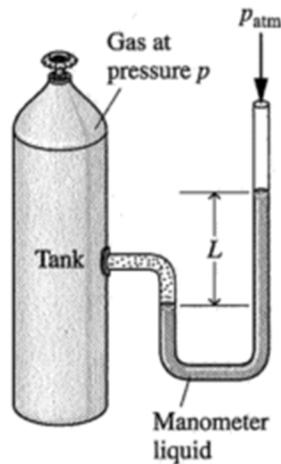
Process 2-3: Constant-pressure expansion to $V_3 = 1.0 \text{ m}^3$

Process 3-1: Constant volume

Sketch the cycle on a p-V diagram labeled with pressure and volume values at each numbered state.

4. As shown in figure, a manometer is attached to a tank of gas in which the pressure is 104.0 kPa. The manometer liquid is mercury, with a density of 13.59 g/cm^3 . If $g = 9.81 \text{ m/s}^2$ and the atmospheric pressure is 101.33 kPa, calculate

- a) the difference in mercury levels in the manometer, in cm.
- b) the gage pressure of the gas, in kPa.



5. A closed system consists of 0.5 kmol of ammonia occupying a volume of 6 m^3 . Determine (a) the weight of the system in N, (b) the specific volume in m^3/kmol and m^3/kg . Let $g=9.81 \text{ m/s}^2$.
6. The absolute pressure inside a tank is 0.4 bars, and the surrounding atmospheric pressure is 98 kPa. What reading would a Bourdon gage mounted in the tank wall give, in kPa? Is this a gage or vacuum reading?
7. Figure below shows a tank within a tank, each containing air. The absolute pressure in tank A is 267.7 kPa. Pressure gage A is located inside tank B and reads 1.4 bars. The U-tube manometer connected to tank B contains mercury. Using data on the diagram determine the absolute pressures inside tank B in kPa and the column length L in cm. The atmospheric pressure surrounding tank B is 101 kPa. The acceleration of gravity is $g = 9.81 \text{ m/s}^2$.

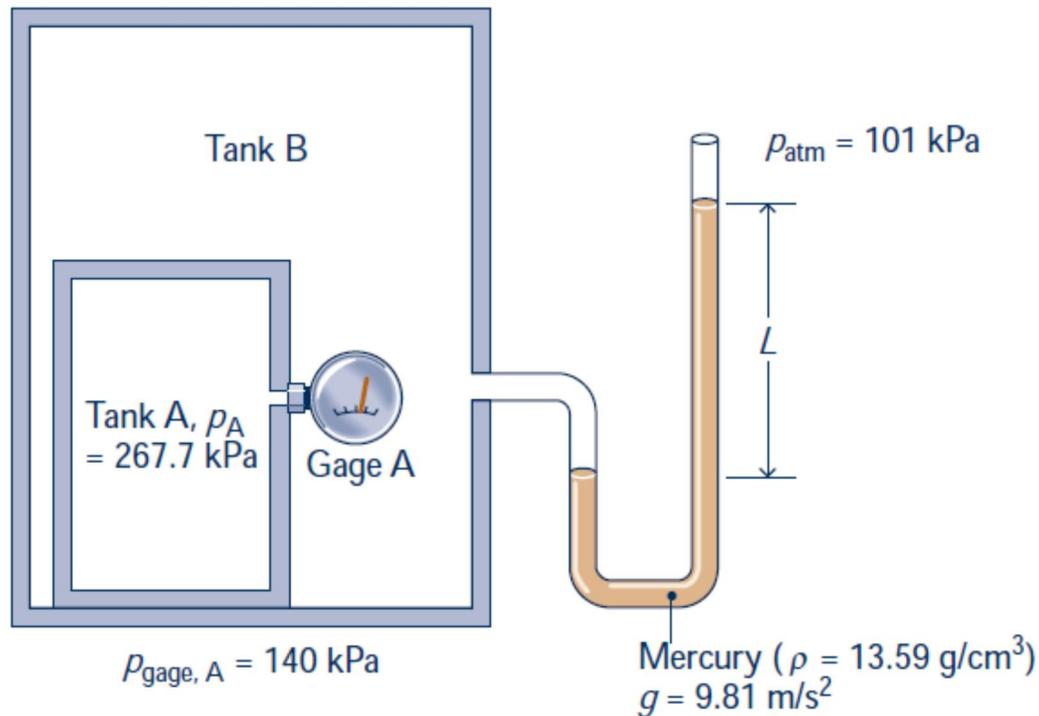


Fig. P1.37

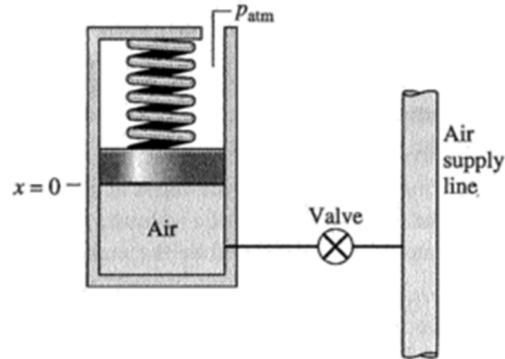
8. A vacuum gage indicates that the pressure of carbon dioxide in a closed chamber is -10 kPa. The pressure of the surrounding atmosphere is equivalent to a 750 -mm column of mercury. The density of mercury is 13.59 g/cm³, and the acceleration of gravity is 9.81 m/s². Determine the absolute pressure of CO₂ within the chamber, in kPa.

9. Air contained within a vertical piston-cylinder assembly is shown in figure. On its top, the 10 -kg piston is attached to a spring and exposed to an atmospheric pressure of 1 bar. Initially, the bottom of the piston is at $x = 0$, and the spring exerts a negligible force on the piston. The valve is opened and air enters the cylinder from the supply line, causing the volume of the air within the cylinder to increase by 3.9×10^{-4} m³. The force exerted by the spring as the air expands within the cylinder varies linearly with x according to

$$F_{\text{spring}} = kx$$

where $k = 10,000$ N/m. The piston face area is 7.8×10^{-3} m². Ignoring friction between the piston and the cylinder wall, determine the pressure of the air

within the cylinder, in bar, when the piston is in its initial position. Repeat when the piston is in its final position. The local acceleration of gravity is 9.81 m/s^2 .



10. You wish to define a new temperature scale. The temperature T on a thermometric scale is defined in terms of a property P by the relation

$$T = a \ln(P) + b$$

, where a and b are constants. Experiments give the values of P as 1.86 and 6.81 at the ice point and steam point respectively. Evaluate the temperature T on the Celsius scale corresponding to a reading of $P = 2.5$ on the new thermometer.