

Homework #2

MEMS 0051 - Introduction to Thermodynamics

Assigned January 18th, 2019

Due January 25th, 2019

Problem #1

Answer the following questions based on the steam tables (Tables B.1.1-B.1.5) provided. Short answers are fine. For all parts (1-5), indicate the location of the state(s) on both $T - \nu$ and $P - \nu$ diagrams, and if applicable, the process between said states. Be sure to distinguish your points and draw the curves the state(s) are on. Illustrate neatly!

1. What phase(s) of H_2O are present at the following conditions?
 - (a) 300 °C, 0.018 $[\text{m}^3/\text{kg}]$
 - (b) 100 °C, 0.001044 $[\text{m}^3/\text{kg}]$
 - (c) 0.5 [MPa], 0.3 $[\text{m}^3/\text{kg}]$
 - (d) 30 [MPa], 300 °C
 - (e) 140 °C, 0.001080 $[\text{m}^3/\text{kg}]$
 - (f) 140 °C, 0.50885 $[\text{m}^3/\text{kg}]$
2. What phase change is occurring for a mass of H_2O going from (e)→(f)?
3. Let's say that we know the pressure and temperature of some mass of H_2O are 10 [MPa] and 200 °C respectively. Can we determine the specific volume of this sample? If so, what is it? If not, why not?
4. Let's say that we know the temperature and pressure of a mass of H_2O are 1 [MPa] and 179.91 °C. Can we determine the specific volume of this sample? If so, what is it? If not, why not?
5. Consider saturated vapor enclosed in a piston-cylinder. The water is cooled, causing an isobaric compression at a constant pressure of 0.1 [MPa] until all of the water is a saturated liquid. What is the final specific volume of the water? What is the saturation temperature at the final state?

Problem #2

Answer the following questions based on the P-T diagram for CO_2 given below. (Short answers are fine, no need to re-draw the diagram on your solution)

1. What phase is CO_2 in at the following temperature and pressure combinations?
 - (a) 250 K, 10^4 [kPa]
 - (b) 170 K, 10^5 [kPa]
 - (c) 190 K, 10^1 [kPa]
 - (d) 330 K, 10^2 [kPa]
2. Consider a piece of dry ice that is dropped into a room at 20 °C and 1 atm (101.3 [kPa]). What phase change(s) will the dry ice undergo?
3. Consider CO_2 gas enclosed in an isothermal chamber fixed at 220 K. More CO_2 is injected into the chamber, causing the internal pressure to rise from 100 [kPa] to 10^4 [kPa]. What phase change(s) will the CO_2 undergo? Be sure to indicate the phase change process?

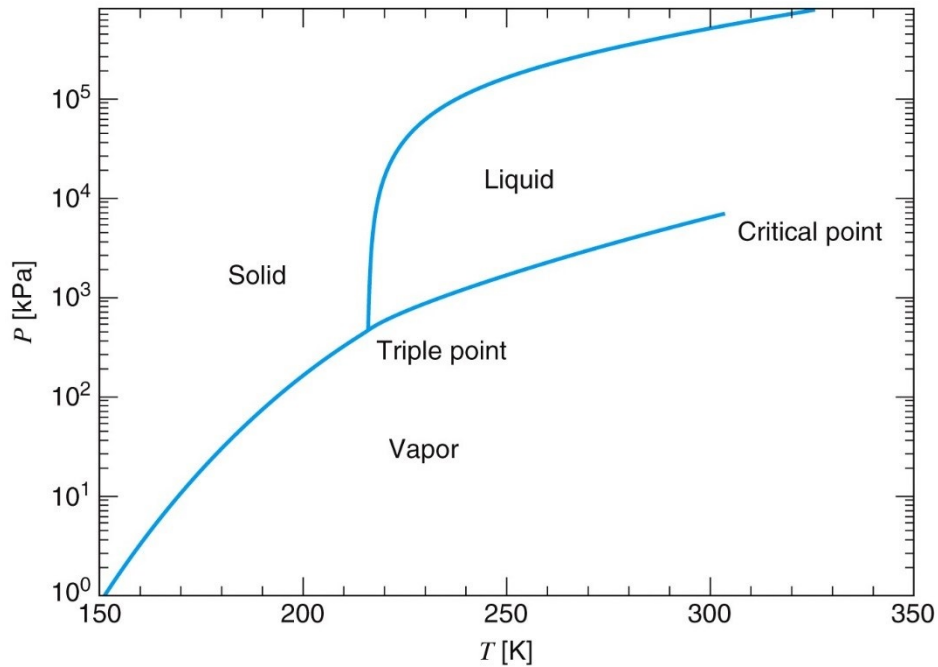


Figure 1: Phase diagram of CO₂

Problem #3

Answer the following questions using Tables B.1.1.-B.1.5.

- Determine the saturation pressure corresponding to a temperature of 283.6 °C.
- Determine the saturation temperature corresponding to a pressure of 5,387 [kPa].
- Determine the saturated liquid specific volume corresponding to a temperature of 102.89 °C.
- Determine the saturated vapor specific volume corresponding to a pressure of 20,089 [kPa].
- Determine the specific volume corresponding to water at a pressure of 128.5 [kPa] and a temperature of 485.3 °C.