

ME 40
Thermodynamics
Spring 2009

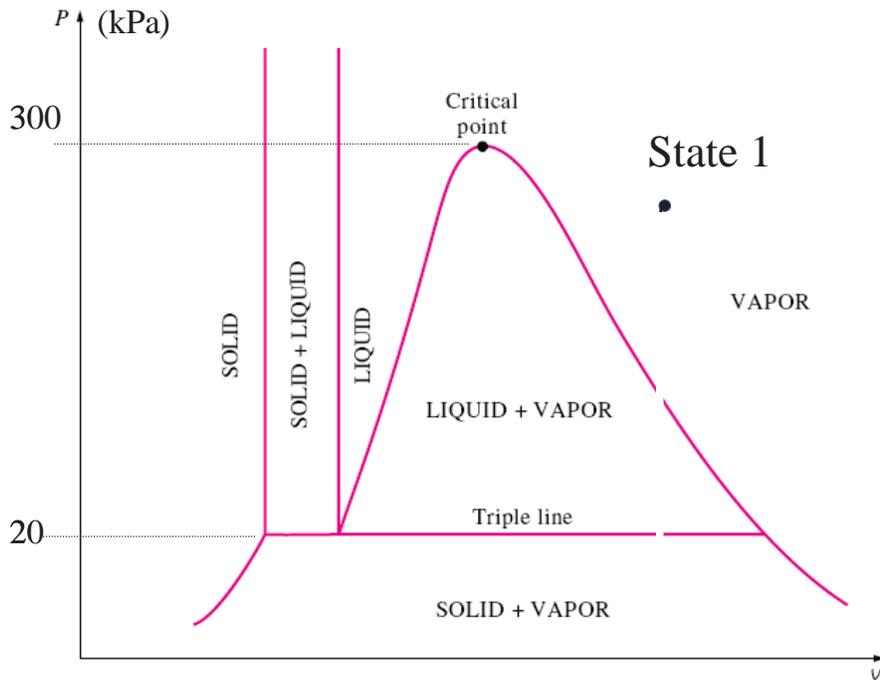
Quiz #1

February 9, 2009

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Question 1: [5 points]



A *rigid* tank contains a pure substance at State 1 as sketched in the above (P, v) diagram. The pressure at State 1 is 285 kPa. Now heat is escaped from the tank and the pressure inside the tank decreases accordingly. At State 2 after reaching equilibrium, the pressure is 10 kPa. Sketch the process on the above (P, v) diagram and describe the phase at State 2.

Question 2: [5 points]

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| <p>A temperature-volume (T, v) diagram showing a saturation curve. The vertical axis is temperature T and the horizontal axis is specific volume v. The curve has a peak. Points A, B, C, D, and E are marked. A horizontal line segment BD is drawn, with point C on it. A dark solid line segment BC is also shown.</p> | <p>Referring to the (T, v) diagram on the left, determine the quality of State C</p> $x = \frac{BC}{BD} = \frac{1 - CD}{BD} = \frac{1 - .65BD}{BD} = 1 - .65 = .35$ <p>Note: $CD = 0.65 BD$ where CD is the distance between points C and D, and BD is the distance between points B and D. The dark solid line represents the saturated vapor and liquid.</p> |
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Question 2: [9 points]

Using the attached tables, complete this chart for H₂O.

| | T (°C) | P (kPa) | h (kJ/kg) | x (quality) | Phase description |
|-----|----------|-----------|-------------|---------------|-------------------|
| i | 95 | | 1250. | | |
| ii | | 300 | 3486.6 | | |
| iii | 150 | 500 | | | |

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Question 3: [10 Points]

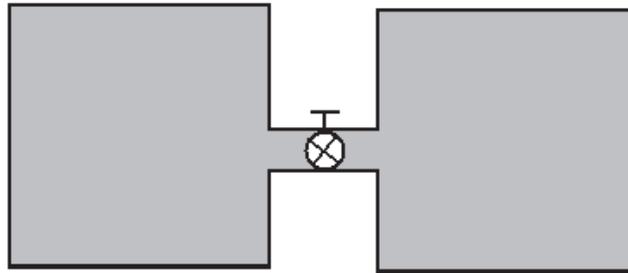
The equation of state for a gas is approximated by $(P + \frac{a}{v^2})v = RT$, where P is pressure, v is specific volume, R gas constant, T temperature, and $a > 0$. At a given state (v, T) , the ideal gas law predicts the pressure $P_{ideal} = RT / v$. Determine if the pressure, P , determined by the equation of state is greater or smaller than P_{ideal} .

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Question 4: [11 points]

Two well-insulated rigid tanks are connected by a valve. Tank A contains 5 kg of superheated *steam* at 800°C and 800kPa. Tank B contains 1 kg of *saturated water mixture* at 150°C and 30% quality. The valve is opened and the two tanks eventually come to thermodynamic equilibrium. Perform a thermodynamics analysis based on conservation of mass and energy to determine if there is any liquid in the final state. (Note that the sizes of the tanks in the sketch are not to the scale.)



Tank A
 $M = 5 \text{ kg}$
 $T = 800^\circ\text{C}$
 $P = 800 \text{ kPa}$

Tank B
 $M = 1 \text{ kg}$
 $T = 150^\circ\text{C}$
 $x = 0.3$