Ain Shams University
Faculty of Engineering
Mechanical Power Dept.

2014/2015
ENGR 360/MEP 112
Thermodynamics

Sheet (3)
Model Answer

Problem (1):

a- Yes. Because it has the same chemical composition throughout.

b- A liquid that is about to vaporize is saturated liquid; otherwise it is compressed liquid.

c- A vapor that is about to condense is saturated vapor; otherwise it is superheated vapor.

d- Yes. The saturation temperature of a pure substance depends on pressure. The higher the pressure, the higher the saturation or boiling temperature.

e- Because one cannot be varied while holding the other constant. In other words, when one changes, so does the other one.

f- At critical point the saturated liquid and the saturated vapor states are identical. At triple point the three phases of a pure substance coexist in equilibrium.

g- Yes.

h- Case (c) when the pan is covered with a heavy lid. Because the heavier the lid, the greater the pressure in the pan, and thus the greater the cooking temperature.

i- Yes. Otherwise we can create energy by alternately vaporizing and condensing a substance.

j- No. Because in the thermodynamic analysis we deal with the changes in properties; and the changes are independent of the selected reference state.

k- Yes; the higher the temperature the lower the h_{fg} value.

l- Quality is the fraction of vapor in a saturated liquid-vapor mixture. It has no meaning in the superheated vapor region.

m- Completely vaporizing 1 kg of saturated liquid at 1 atm pressure since the higher the pressure, the lower the h_{fg}.

n- Yes. It decreases with increasing pressure and becomes zero at the critical pressure.

o- No. Quality is a mass ratio, and it is not identical to the volume ratio.

p- The compressed liquid can be approximated as a saturated liquid at the given temperature.

q- Propane (molar mass = 44.1 kg/kmol) poses a greater fire danger than methane (molar mass = 16 kg/kmol) since propane is heavier than air (molar mass = 29 kg/kmol), and it will settle near the floor. Methane, on the other hand, is lighter than air and thus it will rise and leak out.

r- R_u is the universal gas constant that is the same for all gases whereas R is the specific gas constant that is different for different gases. These two are related to each other by the relation $R = R_u / M$, where M is the molar mass of the gas.

s- Mass m is simply the amount of matter; molar mass M is the mass of one mole in grams or the mass of one kmol in kilograms. These two are related to each other by the relation $m = NM$, where N is the number of moles.

Problem (2):

T, °C	*p*, kPa	*v*, m^3/kg	*u*, kJ/kg	Phase description
50	12.352	4.16	981.76	Saturated mixture
120.21	200	0.8858	2529.1	Saturated vapor
250	400	0.5952	2647.2	Superheated vapor
110	600	0.001051	461.27	Compressed liquid
155.46	550	0.001097	655.16	Saturated liquid
143.61	400	0.2013	1450	Saturated mixture
466.21	4000	0.082	3040	Superheated vapor

Problem (3):

T, °C	p, kPa	h, kJ/kg	x	Phase description
120.21	200	2045.8	0.7	Saturated mixture
140	361.53	1800	0.565	Saturated mixture
177.66	950	752.74	0	Saturated liquid
80	500	335.37	- - -	Compressed liquid
350.0	800	3162.2	- - -	Superheated vapor

Problem (4):

A rigid tank contains steam at a specified state. The pressure, quality, and density of steam are to be determined.

Properties At 220°C $v_f = 0.001190$ m^3/kg and $v_g = 0.08609$ m^3/kg (Table A-4).

Analysis: (*a*) Two phases coexist in equilibrium, thus we have a saturated liquid-vapor mixture. The pressure of the steam is the saturation pressure at the given temperature. Then the pressure in the tank must be the saturation pressure at the specified temperature,

$$P = T_{sat@220°C} = \mathbf{2320\ kPa}$$

(*b*) The total mass and the quality are determined as

$$m_f = \frac{V_f}{v_f} = \frac{1/3 \times (1.8 \text{ m}^3)}{0.001190 \text{ m}^3/\text{kg}} = 504.2 \text{ kg}$$

$$m_g = \frac{V_g}{v_g} = \frac{2/3 \times (1.8 \text{ m}^3)}{0.08609 \text{ m}^3/\text{kg}} = 13.94 \text{ kg}$$

$$m_t = m_f + m_g = 504.2 + 13.94 = 518.1 \text{ kg}$$

$$x = \frac{m_g}{m_t} = \frac{13.94}{518.1} = \mathbf{0.0269}$$

(*c*) The density is determined from

$$v = v_f + x(v_g - v_f) = 0.001190 + (0.0269)(0.08609) = 0.003474 \text{ m}^3/\text{kg}$$

$$\rho = \frac{1}{v} = \frac{1}{0.003474} = \mathbf{287.8 \ kg/m^3}$$

<u>Problem (5)</u>:

Water is boiled at sea level (1 atm pressure) in a pan placed on top of a 3-kW electric burner that transfers 60% of the heat generated to the water. The rate of evaporation of water is to be determined.

Properties The properties of water at 1 atm and thus at the saturation temperature of 100°C are h_{fg} = 2256.4 kJ/kg (Table A-4).

Analysis The net rate of heat transfer to the water is

$$\dot{Q} = 0.60 \times 3 \text{ kW} = 1.8 \text{ kW}$$

Noting that it takes 2256.4 kJ of energy to vaporize 1 kg of saturated liquid water, the rate of evaporation of water is determined to be

$$\dot{m}_{\text{evaporation}} = \frac{\dot{Q}}{h_{fg}} = \frac{1.8 \text{ kJ/s}}{2256.4 \text{ kJ/kg}} = 0.80 \times 10^{-3} \text{ kg/s} = \mathbf{2.872 \ kg/h}$$

<u>Problem (6)</u>:

Water is boiled at 1 atm pressure in a pan placed on an electric burner. The water level drops by 10 cm in 45 min during boiling. The rate of heat transfer to the water is to be determined.

Properties The properties of water at 1 atm and thus at a saturation temperature of T_{sat} = 100°C are h_{fg} = 2256.5 kJ/kg and v_f = 0.001043 m^3/kg (Table A-4).

Analysis The rate of evaporation of water is

$$m_{evap} = \frac{V_{evap}}{v_f} = \frac{(\pi D^2/4)L}{v_f} = \frac{[\pi(0.25\text{ m})^2/4](0.10\text{ m})}{0.001043} = 4.704\text{ kg}$$

$$\dot{m}_{evap} = \frac{m_{evap}}{\Delta t} = \frac{4.704\text{ kg}}{45 \times 60\text{ s}} = 0.001742\text{ kg/s}$$

Then the rate of heat transfer to water becomes

$$\dot{Q} = \dot{m}_{evap} h_{fg} = (0.001742\text{ kg/s})(2256.5\text{ kJ/kg}) = \mathbf{3.93\text{ kW}}$$

Problem (7):

Saturated steam at T_{sat} = 30°C condenses on the outer surface of a cooling tube at a rate of 45 kg/h. The rate of heat transfer from the steam to the cooling water is to be determined.

Assumptions: **1-** Steady operating condition exists. **2** The condensate leaves the condenser as a saturated liquid at 30°C.

Properties The properties of water at the saturation temperature of 30°C are h_{fg} = 2429.8 kJ/kg (Table A-4).

Analysis Noting that 2429.8 kJ of heat is released as 1 kg of saturated vapor at 30°C condenses, the rate of heat transfer from the steam to the cooling water in the tube is determined directly from

$$\dot{Q} = \dot{m}_{evap} h_{fg} = (45\text{ kg/h})(2429.8\text{ kJ/kg}) = 109{,}341\text{ kJ/h} = \mathbf{30.4\text{ kW}}$$

Problem (8):

The average atmospheric pressure in Saint Catherine is 87 kPa. The boiling temperature of water in Saint Catherine is to be determined.

Analysis The boiling temperature of water in Saint Catherine is the saturation temperature corresponding to the atmospheric pressure, which is 87 kPa: 5℃

Problem (9):

The boiling temperature of water in a 5 cm deep pan is given. The boiling temperature in a 40 cm deep pan is to be determined.

Assumptions: Both pans are full of water.

Properties: The density of liquid water is approximately ρ = 1000 kg/m^3.

Analysis: The pressure at the bottom of the 5-cm pan is the saturation pressure corresponding to the boiling temperature of 98°C:

$$P = P_{sat@98^\circ C} = 94.39\text{ kPa} \qquad \text{(Table A-4)}$$

The pressure difference between the bottoms of two pans is

$$\Delta P = \rho g h = (1000\ \text{kg/m}^3)(9.807\ \text{m/s}^2)(0.35\ \text{m})\left(\frac{1\ \text{kPa}}{1000\ \text{kg/m}\cdot\text{s}^2}\right) = 3.43\ \text{kPa}$$

Then the pressure at the bottom of the 40-cm deep pan is

P = 94.39 + 3.43 = 97.82 kPa

Then the boiling temperature becomes

$$T_{\text{boiling}} = T_{\text{sat@97.82 kPa}} = \mathbf{99.0°C} \qquad \text{(Table A-5)}$$

<u>Problem (10)</u>:

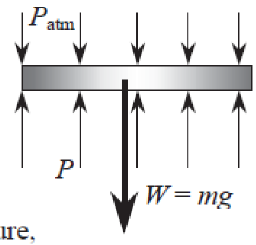
A cooking pan is filled with water and covered with a 4-kg lid. The boiling temperature of water is to be determined.

Analysis The pressure in the pan is determined from a force balance on the lid,

$$PA = P_{atm}A + W$$

or,

$$P = P_{atm} + \frac{mg}{A}$$
$$= (101\ \text{kPa}) + \frac{(4\ \text{kg})(9.81\ \text{m/s}^2)}{\pi(0.1\ \text{m})^2}\left(\frac{1\ \text{kPa}}{1000\ \text{kg/m}\cdot\text{s}^2}\right)$$
$$= 102.25\ \text{kPa}$$



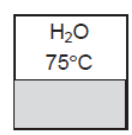
The boiling temperature is the saturation temperature corresponding to this pressure,

$$T = T_{\text{sat@102.25 kPa}} = \mathbf{100.2°C} \qquad \text{(Table A-5)}$$

<u>Problem (11)</u>:

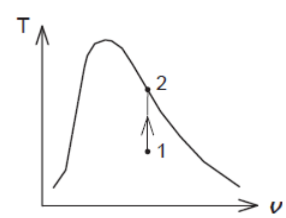
A rigid tank that is filled with saturated liquid-vapor mixture is heated. The temperature at which the liquid in the tank is completely vaporized is to be determined, and the *T*-v diagram is to be drawn.

Analysis: This is a constant volume process (v = V /*m* = constant), and the specific volume is determined to be



$$v = \frac{V}{m} = \frac{2.5\ \text{m}^3}{15\ \text{kg}} = 0.1667\ \text{m}^3/\text{kg}$$

When the liquid is completely vaporized the tank will contain saturated vapor only. Thus,



$$v_2 = v_g = 0.1667\ \text{m}^3/\text{kg}$$

The temperature at this point is the temperature that corresponds to this v_g value,

$$T = T_{\text{sat@}v_g = 0.1667\ \text{m}^3/\text{kg}} = \mathbf{187.0°C} \quad \text{(Table A-4)}$$

Problem (12):

A piston-cylinder device contains a saturated liquid-vapor mixture of water at 800 kPa pressure. The mixture is heated at constant pressure until the temperature rises to 350°C. The initial temperature, the total mass of water, and the final volume are to be determined, and the *P*-v diagram is to be drawn.

Analysis: (a) Initially two phases coexist in equilibrium, thus we have a saturated liquid vapor mixture. Then the temperature in the tank must be the saturation temperature at the specified pressure,

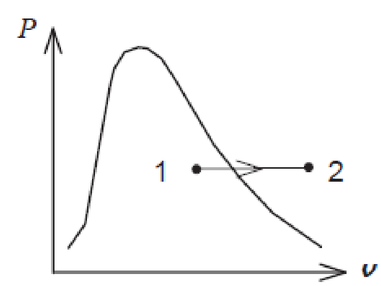
$$T = T_{\text{sat@800 kPa}} = \mathbf{170.41°C}$$

(b) The total mass in this case can easily be determined by adding the mass of each phase,

$$m_f = \frac{V_f}{v_f} = \frac{0.1\ \text{m}^3}{0.001115\ \text{m}^3/\text{kg}} = 89.704\ \text{kg}$$

$$m_g = \frac{V_g}{v_g} = \frac{0.9\ \text{m}^3}{0.24035\ \text{m}^3/\text{kg}} = 3.745\ \text{kg}$$

$$m_t = m_f + m_g = 89.704 + 3.745 = \mathbf{93.45\ kg}$$



(c) At the final state water is superheated vapor, and its specific volume is

$$\left.\begin{aligned} P_2 &= 800\ \text{kPa} \\ T_2 &= 350°\text{C} \end{aligned}\right\} v_2 = 0.35442\ \text{m}^3/\text{kg} \qquad \text{(Table A-6)}$$

Then,

$$V_2 = m_t v_2 = (93.45\ \text{kg})(0.35442\ \text{m}^3/\text{kg}) = \mathbf{33.12\ m^3}$$

Problem (13):

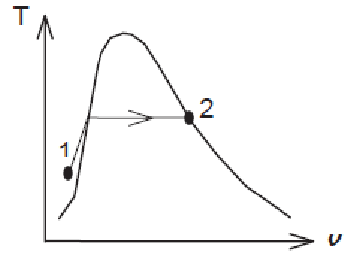
A piston-cylinder device that is initially filled with water is heated at constant pressure until all the liquid has vaporized. The mass of water, the final temperature, and the total enthalpy change are to be determined, and the *T*-v diagram is to be drawn.

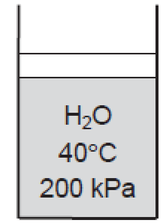
Analysis: Initially the cylinder contains compressed liquid (since $P > P_{\text{sat@40°C}}$) that can be approximated as a saturated liquid at the specified temperature (Table A-4),

$$v_1 \cong v_{\text{f@40°C}} = 0.001008\ \text{m}^3/\text{kg}$$
$$h_1 \cong h_{\text{f@40°C}} = 167.53\ \text{kJ/kg}$$

(a) The mass is determined from

$$m = \frac{V_1}{v_1} = \frac{0.050\ \text{m}^3}{0.001008\ \text{m}^3/\text{kg}} = \mathbf{49.61\ \ kg}$$





(b) At the final state, the cylinder contains saturated vapor and thus the final temperature must be the saturation temperature at the final pressure,

$$T = T_{sat@200\,\text{kPa}} = \mathbf{120.21°C}$$

(c) The final enthalpy is $h_2 =$ $_{hg\ @\ 200\ \text{kPa}}$ = 2706.3 kJ/kg. Thus,

$$\Delta H = m(h_2 - h_1) = (49.61\ \text{kg})(2706.3 - 167.53)\text{kJ/kg} = \mathbf{125{,}943\ \ kJ}$$

<u>Problem (14)</u>:

A rigid vessel that contains a saturated liquid-vapor mixture is heated until it reaches the critical state. The mass of the liquid water and the volume occupied by the liquid at the initial state are to be determined.

Analysis: This is a constant volume process (v = V /*m* = constant) to the critical state, and thus the initial specific volume will be equal to the final specific volume, which is equal to the critical specific volume of water,

$$v_1 = v_2 = v_{cr} = 0.003106\ \text{m}^3/\text{kg} \qquad \text{(last row of Table A-4)}$$

The total mass is

$$m = \frac{V}{v} = \frac{0.3\ \text{m}^3}{0.003106\ \text{m}^3/\text{kg}} = 96.60\ \text{kg}$$

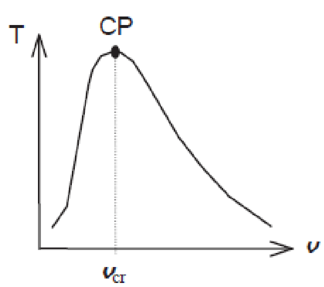
At 150°C, v_f = 0.001091 m^3/kg and v_g = 0.39248 m^3/kg (Table A-4). Then the quality of water at the initial state is

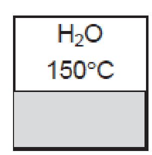
$$x_1 = \frac{v_1 - v_f}{v_{fg}} = \frac{0.003106 - 0.001091}{0.39248 - 0.001091} = 0.005149$$

Then the mass of the liquid phase and its volume at the initial state are determined from

$$m_f = (1 - x_1)m_t = (1 - 0.005149)(96.60) = \mathbf{96.10\ \ kg}$$

$$V_f = m_f v_f = (96.10\ \text{kg})(0.001091\ \text{m}^3/\text{kg}) = \mathbf{0.105\ m^3}$$





Problem (15):

The properties of compressed liquid water at a specified state are to be determined using the compressed liquid tables, and also by using the saturated liquid approximation, and the results are to be compared.

Analysis: Compressed liquid can be approximated as saturated liquid at the given temperature. Then from Table A-4,

$$T = 100°\text{C} \quad \Rightarrow \quad \begin{aligned} v &\cong v_{f\,@100°\text{C}} = 0.001043 \text{ m}^3/\text{kg} \quad (0.72\% \text{ error}) \\ u &\cong u_{f\,@100°\text{C}} = 419.06 \text{ kJ/kg} \quad (1.02\% \text{ error}) \\ h &\cong h_{f\,@100°\text{C}} = 419.17 \text{ kJ/kg} \quad (2.61\% \text{ error}) \end{aligned}$$

From compressed liquid table (Table A-7),

$$\left.\begin{array}{l} P = 15 \text{ MPa} \\ T = 100°\text{C} \end{array}\right\} \begin{array}{l} v = 0.001036 \text{ m}^3/\text{kg} \\ u = 414.85 \text{ kJ/kg} \\ h = 430.39 \text{ kJ/kg} \end{array}$$

The percent errors involved in the saturated liquid approximation are listed above in parentheses.

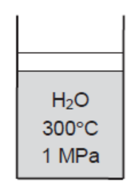
Problem (16):

Superheated steam in a piston-cylinder device is cooled at constant pressure until half of the mass condenses. The final temperature and the volume change are to be determined, and the process should be shown on a *T*-v diagram.

Analysis: (*b*) At the final state the cylinder contains saturated liquid-vapor mixture, and thus the final temperature must be the saturation temperature at the final pressure,

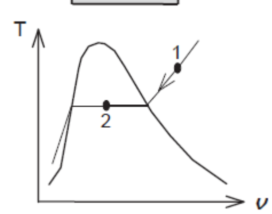
$$T = T_{\text{sat@1 MPa}} = \mathbf{179.88°C} \qquad \text{(Table A-5)}$$

(*c*) The quality at the final state is specified to be $x2 = 0.5$. The specific volumes at the initial and the final states are



$$\left.\begin{array}{l} P_1 = 1.0 \text{ MPa} \\ T_1 = 300°\text{C} \end{array}\right\} v_1 = 0.25799 \text{ m}^3/\text{kg} \qquad \text{(Table A-6)}$$

$$\left.\begin{array}{l} P_2 = 1.0 \text{ MPa} \\ x_2 = 0.5 \end{array}\right\} \begin{aligned} v_2 &= v_f + x_2 v_{fg} \\ &= 0.001127 + 0.5 \times (0.19436 - 0.001127) \\ &= 0.09775 \text{ m}^3/\text{kg} \end{aligned}$$



Thus,

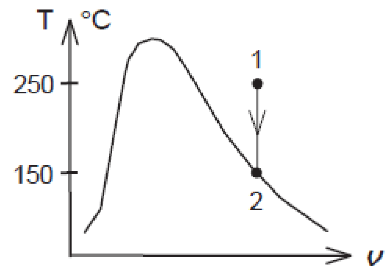
$$\Delta V = m(v_2 - v_1) = (0.8 \text{ kg})(0.09775 - 0.25799)\text{m}^3/\text{kg} = \mathbf{-0.1282\ m^3}$$

Problem (17):

The water in a rigid tank is cooled until the vapor starts condensing. The initial pressure in the tank is to be determined.

Analysis: This is a constant volume process (v = V /*m* = constant), and the initial specific volume is equal to the final specific volume that is

$$v_1 = v_2 = v_{g@150°C} = 0.39248 \text{ m}^3/\text{kg} \qquad \text{(Table A-4)}$$



Since the vapor starts condensing at 150°C, then from Table A-6,

$$\left.\begin{array}{l} T_1 = 250°\text{C} \\ v_1 = 0.39248 \text{ m}^3/\text{kg} \end{array}\right\} P_1 = \mathbf{0.60\ MPa}$$

Problem (18):

Heat is lost from a piston-cylinder device that contains steam at a specified state. The initial temperature, the enthalpy change, and the final pressure and quality are to be determined.

Analysis: (*a*) The saturation temperature of steam at 3.5 MPa is

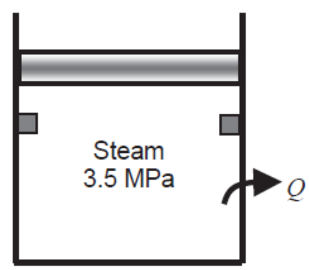
$$T_{\text{sat@3.5 MPa}} = 242.6°\text{C} \quad \text{(Table A-5)}$$

Then, the initial temperature becomes

$$T_1 = 242.6 + 5 = \mathbf{247.6°C}$$

Also,

$$\left.\begin{array}{l} P_1 = 3.5 \text{ MPa} \\ T_1 = 247.6°\text{C} \end{array}\right\} h_1 = 2821.1 \text{ kJ/kg} \qquad \text{(Table A-6)}$$



(*b*) The properties of steam when the piston first hits the stops are

$$\left.\begin{array}{l} P_2 = P_1 = 3.5 \text{ MPa} \\ x_2 = 0 \end{array}\right\} \begin{array}{l} h_2 = 1049.7 \text{ kJ/kg} \\ v_2 = 0.001235 \text{ m}^3/\text{kg} \end{array} \qquad \text{(Table A-5)}$$

Then, the enthalpy change of steam becomes

$$\Delta h = h_2 - h_1 = 1049.7 - 2821.1 = \mathbf{-1771\ kJ/kg}$$

(*c*) At the final state

$$\left.\begin{array}{l} v_3 = v_2 = 0.001235 \text{ m}^3/\text{kg} \\ T_3 = 200°\text{C} \end{array}\right\} \begin{array}{l} P_3 = \mathbf{1555\ kPa} \\ x_3 = \mathbf{0.0006} \end{array} \qquad \text{(Table A-4 or EES)}$$

The cylinder contains saturated liquid-vapor mixture with a small mass of vapor at the final state.

Problem (19):

An automobile tire is inflated with air. The pressure rise of air in the tire when the tire is heated and the amount of air that must be bled off to reduce the temperature to the original value are to be determined.

Assumptions: **1** At specified conditions, air behaves as an ideal gas. **2** The volume of the tire remains constant.

Properties: The gas constant of air is R = 8.3144/29 = 0.287 kJ/kg.K.

Analysis: Initially, the absolute pressure in the tire is

$$P_1 = P_g + P_{atm} = 210 + 100 = 310 \text{kPa}$$

Treating air as an ideal gas and assuming the volume of the tire to remain constant, the final pressure in the tire can be determined from

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \longrightarrow P_2 = \frac{T_2}{T_1} P_1 = \frac{323 \text{ K}}{298 \text{ K}} (310 \text{ kPa}) = 336 \text{ kPa}$$

Thus the pressure rise is

$$\Delta P = P_2 - P_1 = 336 - 310 = \mathbf{26 \text{ kPa}}$$

The amount of air that needs to be bled off to restore pressure to its original value is

$$m_1 = \frac{P_1 V}{R T_1} = \frac{(310 \text{ kPa})(0.025 \text{ m}^3)}{(0.287 \text{ kPa} \cdot \text{m}^3/\text{kg} \cdot \text{K})(298 \text{ K})} = 0.0906 \text{ kg}$$

$$m_2 = \frac{P_1 V}{R T_2} = \frac{(310 \text{ kPa})(0.025 \text{ m}^3)}{(0.287 \text{ kPa} \cdot \text{m}^3/\text{kg} \cdot \text{K})(323 \text{ K})} = 0.0836 \text{ kg}$$

$$\Delta m = m_1 - m_2 = 0.0906 - 0.0836 = \mathbf{0.0070 \text{ kg}}$$

Problem (20):

Two rigid tanks connected by a valve to each other contain air at specified conditions. The volume of the second tank and the final equilibrium pressure when the valve is opened are to be determined.

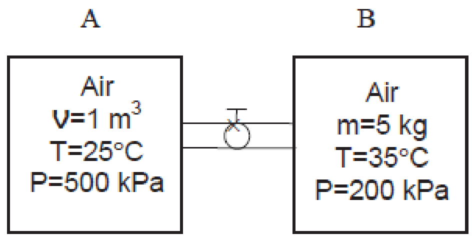
Assumptions: At specified conditions, air behaves as an ideal gas.

Properties: The gas constant of air is R = 8.3144/29 = 0.287 kJ/kg.K.

Analysis: Let's call the first and the second tanks A and B. Treating air as an ideal gas, the volume of the second tank and the mass of air in the first tank are determined to be

$$V_B = \left(\frac{m_1 R T_1}{P_1} \right)_B = \frac{(5 \text{ kg})(0.287 \text{ kPa} \cdot \text{m}^3/\text{kg} \cdot \text{K})(308 \text{ K})}{200 \text{ kPa}} = \mathbf{2.21 \text{ m}^3}$$

$$m_A = \left(\frac{P_1 V}{RT_1}\right)_A = \frac{(500 \text{ kPa})(1.0 \text{ m}^3)}{(0.287 \text{ kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(298 \text{ K})} = 5.846 \text{ kg}$$



Thus,

$$V = V_A + V_B = 1.0 + 2.21 = 3.21 \text{ m}^3$$
$$m = m_A + m_B = 5.846 + 5.0 = 10.846 \text{ kg}$$

Then the final equilibrium pressure becomes

$$P_2 = \frac{mRT_2}{V} = \frac{(10.846 \text{ kg})(0.287 \text{ kPa}\cdot\text{m}^3/\text{kg}\cdot\text{K})(293 \text{ K})}{3.21 \text{ m}^3} = \mathbf{284.1 \text{ kPa}}$$

<u>Problem (21)</u>:

A rigid tank contains an ideal gas at a specified state. The final temperature is to be determined for two different processes.

Analysis: (*a*) The first case is a constant volume process.

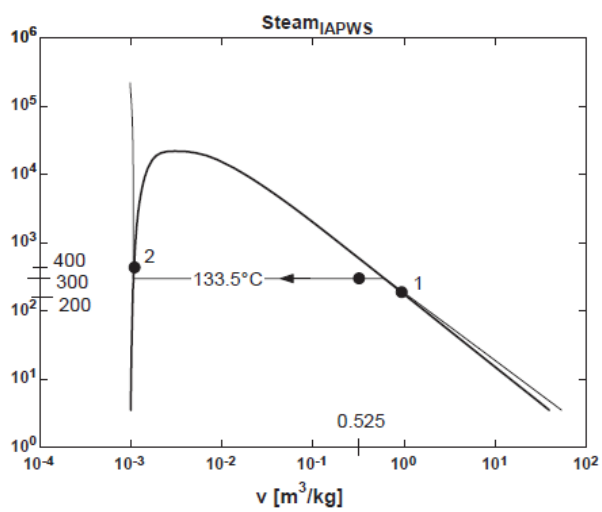
$$T_2 = \frac{m_1}{m_2}\frac{P_2}{P_1}T_1 = (2)\left(\frac{100 \text{ kPa}}{300 \text{ kPa}}\right)(600 \text{ K}) = \mathbf{400 \text{ K}}$$

(*b*) The second case is a constant volume and constant mass process.

$$P_2 = \frac{T_2}{T_1}P_1 = \left(\frac{400 \text{ K}}{600 \text{ K}}\right)(300 \text{ kPa}) = \mathbf{200 \text{ kPa}}$$

<u>Problem (22)</u>:

(a) On the P-v diagram, the constant temperature process through the state P= 300 kPa, v = 0.525 m^3/kg as pressure changes from P1 = 200 kPa to P2 = 400 kPa is to be sketched. The value of the temperature on the process curve on the P-v diagram is to be placed.



(b) On the T-v diagram the constant specific volume process through the state T = 120°C, v = 0.7163 m^3/kg from P_1= 100 kPa to P_2 = 250 kPa is to be sketched. For this data set, the temperature values at states (1) and (2) on its axis is to be placed. The value of the specific volume on its axis is also to be placed.