Zachary Ahmad
PSE 380
Due: 2/15/2021

2.3) When you skate on ice, a thin liquid film forms under the skate; why?

Pressure lowers the melting point of the ice. Since the weight of a human is pushing down on the blades, the ice is melting and causing a thin film of liquid water to form.

- I understand how to solve this problem.

Zachary Ahmad
PSE 3 80
Due 02/15/2021

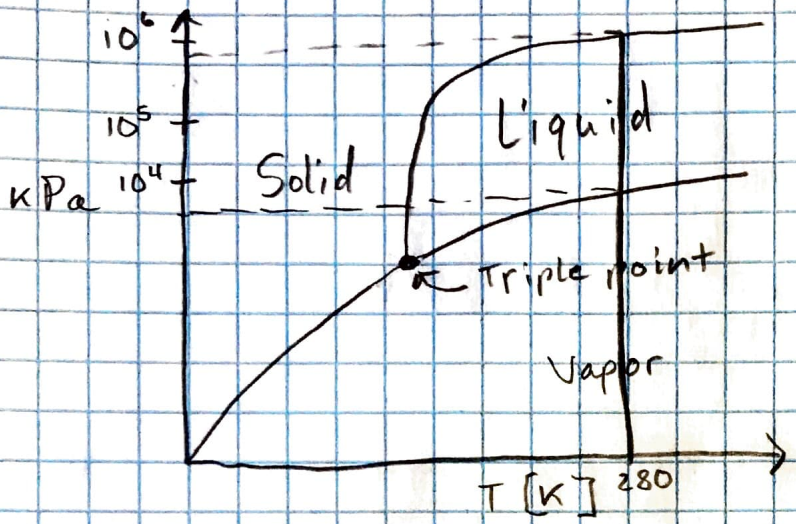
2.4) At higher elevations, as in mountains, air pressure is lower; how does that affect the cooking of food?

The decreased air pressure and temperatures cause the boiling point of water to lower which increases the cooking time of a meal. We must also consider that lowering water's boiling point below 100°C might mean that boiled food is undercooked.

- I understand how to solve this problem.

Zachary Ahmad
PSE 380
Due: 02/15/2021

2.16) Carbon dioxide at 280 K can be in three different phases: vapor, liquid, and solid. Indicate the pressure range for each phase.



from Fig 2.5 (pg 43)

liquid - 4×10^3 kPa $< P <$ 4×10^5 kPa
Vapor - $P < 4 \times 10^3$ kPa
Solid - 4×10^5 kPa $< 10^6$ kPa

- I understand how to solve this problem.

Zachary Ahmad
PSE 380
Due: 2/15/2021

2.24) Give the phase for the following states:

a) CO_2 @ T = 40°C and P = 0.5 MPa

b) Air @ T = 20°C and P = 200 kPa

c) NH_3 @ T = 170°C and P = 600 kPa

a) Table B.3.1., we find:

at P = 0.5 MPa, $T \gg T_{sat}$, (40° > -50°C)

Cross-referencing with Table A.2., we see the temp at a given state, T = 40°C + 273 = 313K

so, CO_2 is in superheated vapor phase

b) Table A.7.2., at 200 kPa or 0.2 MPa,

@ 0.2 MPa $T > T_c$ $T_c = -140.52°C$

thus, superheated vapor phase.

c) B.2.2., @ P = 600 kPa or 0.6 MPa

$T \gg T_c$ since $T_{sat} = 9.28°C$ and T = 170°C

so, superheated vapor phase.

- I understand how to solve this problem.

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PSE 380
Due: 02/15/2021

2.38) Give the missing property of P, T, v, and x for CH_4 at
a) T = 155 K, v = 0.04 m^3/kg
b) T = 350 K, v = 0.25 m^3/kg

CH_4 = Methane

a) Table B.7.1
@ T = 155 K
P_{sat} = 1295.6 kPa
v_f = 0.002877 m^3/kg
v_g = 0.04892 m^3/kg
v_{fg} = 0.04605 m^3/kg

We know from p. 50, eq 2.2 that
$v = v_f + x v_{fg}$
so $x = \frac{v - v_f}{v_{fg}}$

Phase is saturated mixture since P = 1295.6 kPa

$$x = \frac{0.04 - 0.002877}{0.04605} = 0.806$$

b) Table B.7.1 (I also slightly used B.7.2)

@ T = 350 K
v = 0.30067 m^3/kg @ P = 600 kPa
v = 0.22510 m^3/kg @ P = 800 kPa

using interpolation formula from p. 55

$$P = 600 + \frac{0.25 - 0.30067}{0.22510 - 0.30067}(800 - 600)$$

P = 734 kPa and x is undefined (superheated)

- I do not fully understand how to solve this problem.

Zachary Ahmad
PSE 380
Due: 2/15/2021

2.41) Give the missing property of P, T, v, and x for:
a) R-410a @ 25°C, v = 0.01 m^3/kg
b) R-410a @ 400 kPa, v = 0.075 m^3/kg
c) Ammonia @ 10°C, v = 0.1 m^3/kg

a) Table B.4.1: Since v of R-410a < v sat vapor or $v < v_g$, a 2 phase region of L and V exists.

$v_f = 0.000944\ m^3/kg$
$v_{fg} = 0.01420\ m^3/kg$

$$x = \frac{v - v_f}{v_{fg}} \rightarrow x = \frac{0.01 - 0.000944}{0.01420}$$

quality x = **0.6377**

b) Table B.4.2.: @ P = 400 kPa, $v_g = 0.01514\ m^3/kg$

Since $v > v_g$, vapor is superheated so x is undefined

From Table F.9.2, $v = 0.075\ m^3/kg$ is between $0.07227\ m^3/kg$ & $0.07916\ m^3/kg$. From Table F.4.2, $v_1 = 0.07227\ m^3/kg$ is $T_1 = 0°C$ and $v_2 = 0.07916\ m^3/kg$ is $T_2 = 20°C$

Interpolation eq: $T = T_1 + (T_2 - T_1) \times \frac{v - v_1}{v_2 - v_1}$

$$\rightarrow T = 0 + (20-0)\left(\frac{0.075 - 0.07227}{0.07916 - 0.07227}\right) = 7.92°C = T$$

c) Table B.4.1. @ T = 10°C

$v_f = 0.0016\ m^3/kg$
$v_g = 0.01514\ m^3/kg$
$v_{fg} = 0.20381\ m^3/kg$
$P_{sat} = 615.2$ kPa from table

Since $v < v_g$, L & V phase $\rightarrow x = \frac{v - v_f}{v_{fg}}$, $x = \frac{0.1 - 0.0016}{0.20381}$

$x = 0.4828$

- I understand how to solve this problem.

6

Zachary Ahmad
PSE 380
Due: 2/15/2021

2.42) You want a pot of water to boil at 105°C. How heavy a lid should you put on the 15-cm-diameter pot when $P_{atm} = 101$ kPa?

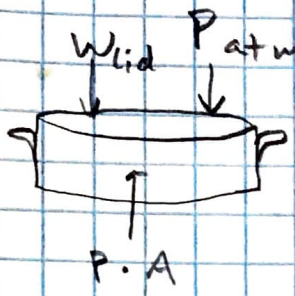

Table B.1.1

@105°C $P_{sat} = 120.8$ kPa

cross sectional area:

$$A = \frac{\pi}{4} d^2, \quad A = \frac{\pi}{4} \times (0.15)^2 = 0.017672\ m^2$$

Now, $P_{sat} = P_{atm} + P_{lid}$

$P_{lid} = P_{sat} - P_{atm}$

$= 120.8 - 101 = 19.8$ kPa

$$P_{lid} = \frac{W_{lid}}{A} \rightarrow \frac{W_{lid}}{0.017672} = 19\,800, \quad W_{lid} = 349.9\ N$$

$W_{lid} = m_{lid} g \rightarrow m \times 9.81 = 349.9\ N$

$\boxed{m = 35.7\ kg}$

- I understand how to solve this problem.

Zachary Ahmad
PSE 380
Due: 2/15/2021

2.44) A sealed rigid vessel has volume of $1\ m^3$ and contains 2 kg of water at 100°C. The vessel is now heated. If a safety pressure valve is installed, at what pressure should the valve be set to have a maximum temp of 200°C?

Given: $T_1 = 100°C$
$T_2 = 200°C$
$V = 1\ m^3$
$m = 2\ kg$

first, find v

$$v = \frac{V}{m} = \frac{1}{2} = 0.5\ m^3/kg$$

From Table B.1.3., for $T = 200°C$, $v = 0.53422\ m^3/kg$
↳ and $P = 400\ kPa$

and for $T = 200°C$ & $P = 500\ kPa$, $v = 0.42492\ m^3/kg$

Interpolation: $P_2 = 400 + \frac{0.5 - 0.53422}{0.42492 - 0.53422}(500 - 400)$

$$= 431.3\ kPa$$

- I understand how to solve this problem.

Zachary Ahmad
PSE 380
Due: 2/15/2021

2.57) A sealed rigid vessel of $2m^3$ contains a saturated mixture of liquid and vapor R-134a @ 10°C. If it is heated to 50°C, the liquid phase disappears. Find the pressure @ 50°C & the initial mass of the liquid.

Given: $T_1 = 10°C$ & $T_2 = 50°C$
$V = 2m^3$ $P_2 = ?$ $m_1 = ?$

From Table B.5.1 @ $T_2 = 50°C$, $P_2 = 1318.1\ kPa$

$v_1 = v_2 = 0.01512\ m^3/kg$
@ $T = 10°C$ $v_f = 0.000794\ m^3/kg$, $v_{fg} = 0.04866\ m^3/kg$

$m_1 = (1 - x_1)m$ & $v_1 = v_f + x_1 v_{fg}$

so $m = \frac{V}{v} = \frac{2}{0.01512} = 132.24$

$x_1 = \frac{0.01512 - 0.000794}{0.04866} = 0.2944$

$m_1 = (1 - 0.2944)(132.24)$

so $m_1 = 93.3\ kg$

- I understand how to solve this problem.