Table 3.9 How to Find the Thermodynamic "State"

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			Compressed Liquid *If*	Mixture of Liquid and Vapor *If*	Superheated Vapor *If*
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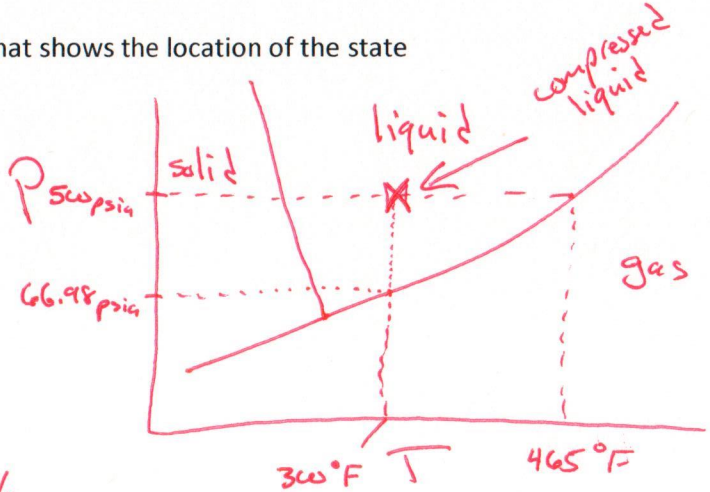
Given: Water at $T = 300°F$, $p = 500$ *psia*

Find: *v, ρ, u, h, s*

Draw diagram that shows the location of the state



Which table to find p_{sat}? C1.a @ 300°F $P_{sat} = 66.98$ psia

Which table to find T_{sat}? C2.a @ 500psia $T_{sat} = 465.5°F$

Current state is????

Compressed Liquid

Which table to find data about Compressed Water (liquid)?

C4.a $v = 0.017416$ ft³/lbm

$\rho = \frac{1}{v} = 57.418$ lbm/ft³

$u = 268.92$ Btu/lbm

$h = 270.53$ Btu/lbm

$s = 0.43641$ Btu/lbm·R

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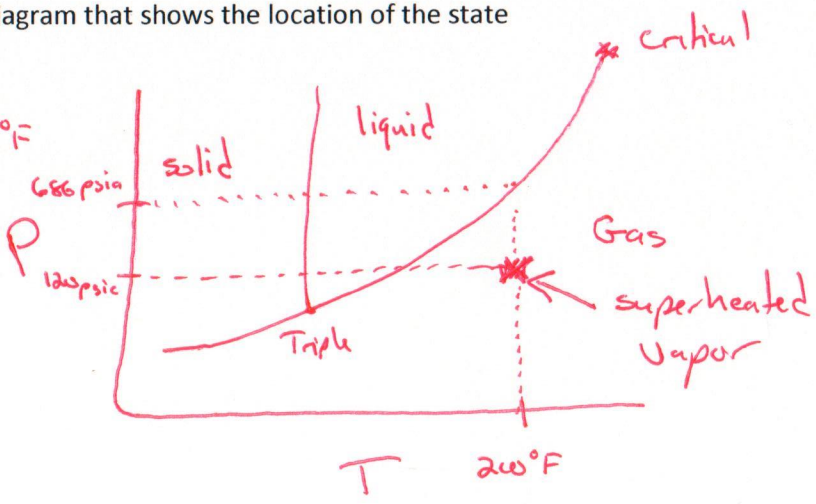
Given: R-22 at $T = 200°F$, $p = 120$ psia

Find: *v, u, h*

Draw diagram that shows the location of the state



Which table to find p_{sat}? C9.a $P_{sat} = 686.36$ psia

Which table to find T_{sat}? C9.a T_{sat} between 60°F and 70°F

C10.a $T_{sat} = 61.95°F$

Current state is????

Superheated vapor

Which table to find data about Superheated R-22?

C10.a $v = 0.64036$ ft³/lbm

$u = 121.16$ Btu/lbm

$h = 135.38$ Btu/lbm

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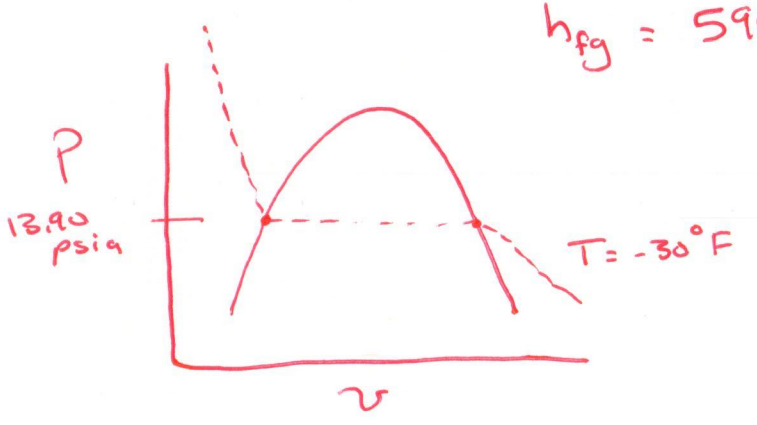
Given: Ammonia at $T = -30°F$

Find: *vapor pressure, p_{sat} and h_{fg}*

Which table can we find data about *vapor pressure, p_{sat} and h_{fg}*?

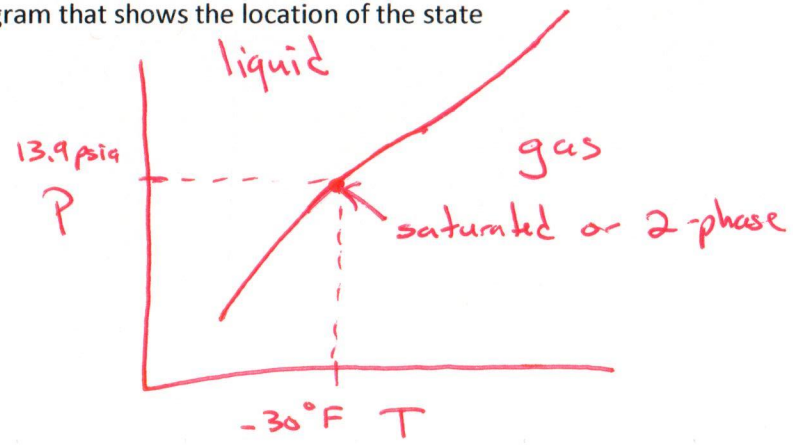
C.5a @ $-30°F$ $p_{sat} = 13.90$ psia

$h_{fg} = 590.7$ Btu/lbm



$P_{vap} = P_{sat}$

Draw diagram that shows the location of the state



$h_g = 601.4$ Btu/lbm

$h_f = +10.7$ Btu/lbm

$h_g - h_f = h_{fg} = 590.7$ Btu/lbm

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Given: R-134a

Find: The normal boiling point (temperature)

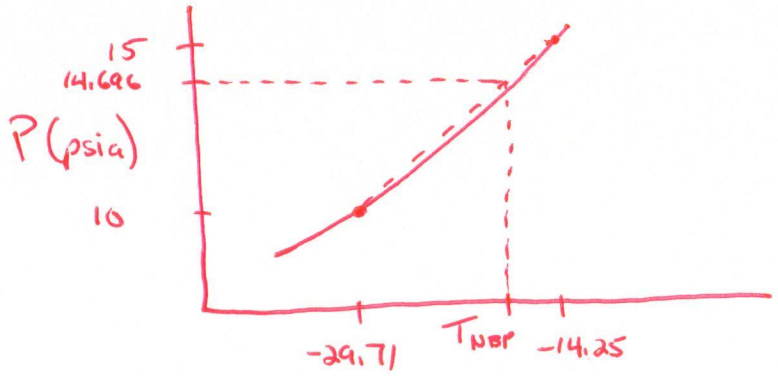
Draw diagram that shows the location of the state

What is normal pressure? 14.696 psia

Which table to find T_{sat}? C.7b

How do we calculate at a value between tabulated values?

P (psia)	T (°F)
10	-29.71
14.696	T_{NBP}
15	-14.25



$$T_{NBP} = -29.71\,°F + (14.696 - 10)\,psi \times \left(\frac{-14.25 - (-29.71)\,°F}{(15-10)\,psi}\right)$$

$$T_{NBP} = -15.19\,°F$$

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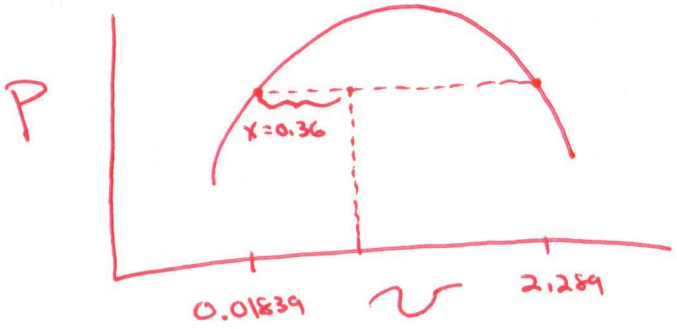
Given: Water at $p = 200$ psia, $x = 0.36$

Find: v, h

Draw diagram that shows the location of the state



Current state is????

2-phase mixture

Which table to find Saturated water?

C.2a

$v = (1-x)v_f + x v_g$

$v_f = 0.01839$ ft³/lbm

$v_g = 2.289$ ft³/lbm

$v = 0.8358$ ft³/lbm

$h = (1-x)h_f + x h_g$

$h_f = 355.6$ Btu/lbm

$h_g = 1199.3$ Btu/lbm

$h = 659.33$ Btu/lbm

alternative

$h = h_f + x h_{fg}$

$h = 659.33$ Btu/lbm

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Given: Ammonia at $T = 200°F$, $h = 700$ BTU/lbm

Find: p

C.5a only goes to 125°F

Which table can we find p_{sat}?

Which table can we find the critical point? C.12a $T_{cr} = 729.8R = 270.13°F$

Current state is????

Below T_{cr}, Superheated Vapor

Which table to find Superheated ammonia?

C.6a → interpolate

@ T = 200°F

h (Btu/lbm)	P (psia)
701.9	220
700	P
699.8	240

$$P = 220\,psia + (700 - 701.9)\,\frac{Btu}{lbm} \times \frac{(240 - 220)\,psia}{(699.8 - 701.9)\,Btu/lbm}$$

P = 238 psia

7

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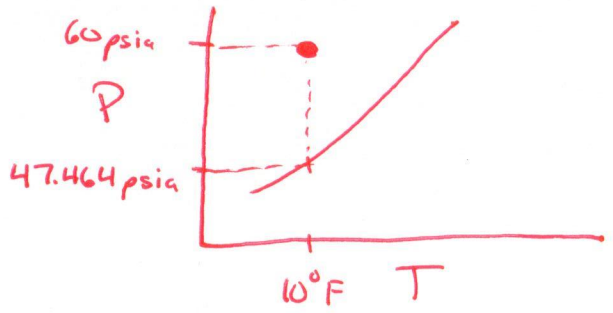
Given: R-22 at T = 10°F, *p = 60 psia*

Find: *v, u, h*

Draw diagram that shows the location of the state



Which tables to find p_{sat}? C.9a

Current state is????

Compressed liquid

Which table to find Compressed R-22? Don't have one :(

How are we going to calculate values that doesn't exist in the table? What assumption can we make about liquids?

Assume incompressible $v = v_{sat}$ @ 10°F = 0.01209 ft^3/lbm

$u = u_{sat}$ @ 10°F = 13.00 Btu/lbm

$h \rightarrow$ from $u + pv$

more →

To find h, we first need to find h_{sat}

$$h = u + pv$$

$$h_{sat} = u_{sat} + P_{sat} v_{sat}$$

$$= 13.00 \ \text{Btu/lbm} + (47.464 \ \text{psia})(0.01209 \ \text{ft}^3/\text{lbm})\left(\frac{\text{lbf}}{\text{in}^2 \cdot \text{psi}}\right)\left(\frac{144 \ \text{in}^2}{\text{ft}^2}\right)\left(\frac{\text{Btu}}{778 \ \text{ft}\cdot\text{lbf}}\right)$$

$$h_{sat} = 13.10 \ \text{Btu/lbm}$$

Now, to get $h_{(60\text{psia})}$ we can use

$$h_{(60\text{psia})} = h_{sat} + v_{sat} \Delta P$$

$$= 13.10 \ \text{Btu/lbm} + (0.01209 \ \text{ft}^3/\text{lbm})(60 - 47.464)\text{psi}\left(\frac{\text{lbf}}{\text{in}^2 \cdot \text{psi}}\right)\left(\frac{144 \ \text{in}^2}{\text{ft}^2}\right)\left(\frac{\text{Btu}}{778 \ \text{ft}\cdot\text{lbf}}\right)$$

$$\boxed{h_{(60\text{psia})} = 13.13 \ \text{Btu/lbm}}$$