Problem Set 3, PS3 due Monday May 24

PS3-1 Determine the temperature at which water will boil in Denver. In Denver the atmospheric pressure is 83.4 kpa.

PS3-1 Water at 300 C and an unknown pressure is contained in a rigid tank. The tank is cooled and the water begins to condense at 180 C. Determine the initial pressure in the tank.

PS3-3 Heat is added to water in a piston cylinder device until the contents are all vapor. There are 50 liters of water in the piston cylinder device initially at 25 C and 300 kPa. Determine a) the mass of the water, b) the final temperature, c) the total enthalpy change and sketch the process on a sketch of a temperature volume diagram of the process.

PS3-4 Superheated water is allowed to cool to 250 F in a constant specific volume process. The initial condition of the steam is 180 psi and 500 F. What is the final pressure, temperature and enthalpy of the steam? Sketch a temperature volume property diagram for the process.

PS3-1

$T_{boiling} = T_{saturation} @ 83.4\,kPa$

From water Temperature Table

T	P
90	70.183
	83.4
95	84.609

$$ratio = \frac{84.609 - 83.4}{84.609 - 70.183} = .0838$$

$$T_{boiling} = 95 - .0838 \times (95 - 90)$$

$$T_{boiling} = 94.58\,C$$

PS3-2

$v_2 = v_{saturation} @ 180\,C = .19384$

$v_1 = v_2$

$p_2 = pressure @ (v_2, 300C)$

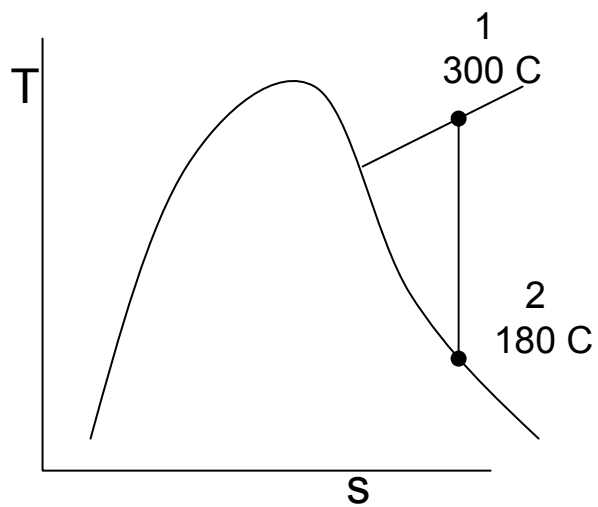
water Superheat Table

	p = 1.2Mpa		p = 1.2MPa
300 C	v = .21386	v = .19386	v = .18233

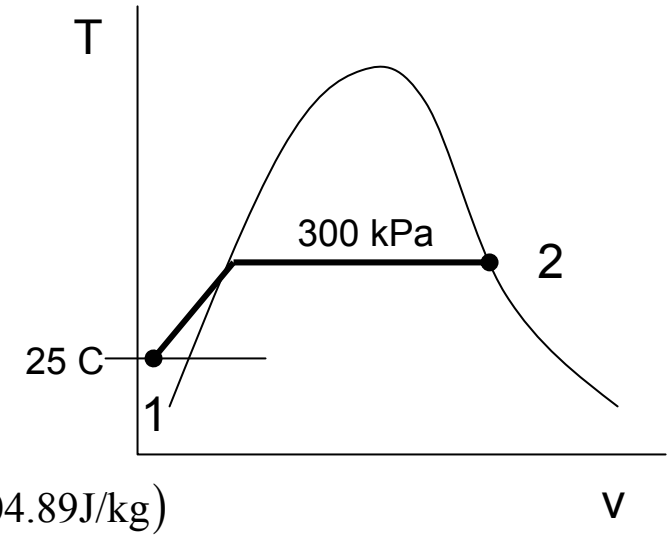
$$ratio = \frac{.21386 - .19384}{.21385 - .18233} = .634$$

$$p = 1{,}2MPa + .634 \times (1.4 - 1.2)$$

$$p = 1.33MPa$$



PS3-3



$@\,25C,\ 300\ kPa,\ v_1 = v_f\ @\ 25\ C = .001003 m^3/kg$

a) $m_f = \dfrac{V_f}{v_f} = \dfrac{.05\ m^3}{.001003\ m^3/kg} = 49.85\ kg$

b) $T = T_{saturation}\ @\ 300\ kPa = 133.55\ C$

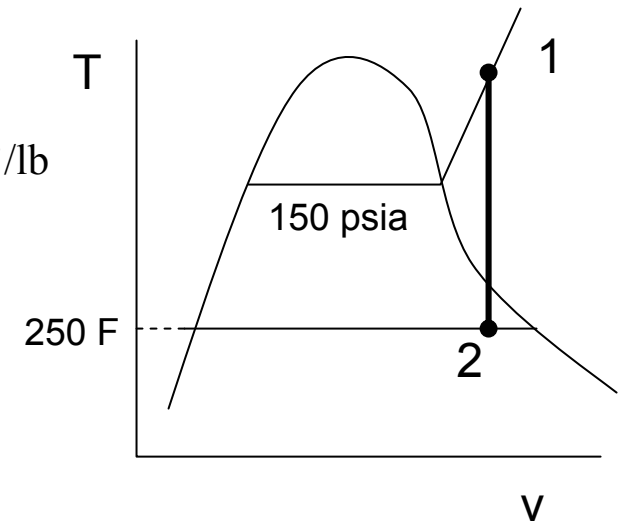
c) $h_2 = h_g\ @\ 300\ kPa = 2725.3\ kJ/kg$

$h_1 = h_f @ 25C = 14.89\ J/kg$

$H_2 - H_1 = m \times (h_2 - h_1) = 49.85kg \times (2725.3kJ/kg - 104.89J/kg)$

$H_2 - H_1 = 130{,}627.4kJ$

PS3-4



$@\,180\ psia, 500\ F, v_1 = 3.042 ft^3/lb$ Superheat Table

at 250 and saturation , $v_f = .017\ ft^3/lb,\ v_g = 13.826\ ft^3/lb$

a) $p_2 = 29.82$ satruration pressure at 250 psia

b) $x = \dfrac{3.042\ ft^3/lb - .017\ ft^3/lb}{13.826\ ft^3/lb - .017\ ft^3/lb} = .2.19$

c) $h = h_f + x \times h_{fg}$

$h = 218.59\ BTU/lb + .219 \times 945.6\ BTU/lb$

$h = 425.7\ BTU/lb$