B.5/10

Question #1 [10 pts]

1) As described in Charles Darwin's "*The Voyage of the Beagle*", during his travel at the republic of Mendoza (through the Andes where elevation is at around 11,000 ft):

> "*We were now in the republic of Mendoza. The elevation was probably not under 11,000 feet .... At the place where we slept ... the potatoes, after remaining for some hours in the boiling water, were nearly as hard as ever. The pot was left on the fire all night, and next morning it was boiled again, but yet the potatoes were not cooked.*"

(1) Can you explain why?

elevation ↑ ⇒ pressure ↓ ⇒ boiling pt ↓ ∴ less energy to cook the food so it takes longer

2) A system contains water at 0.20 MPa, 150°C. The phase of this water is:

(1) **a)** Liquid **b)** Liquid-vapor saturated mixture **c)** Superheated vapor **d)** Solid

3) A cooling pipe contains a flowing refrigerant R-134a at a temperature of 30 °C with a specific volume of 0.04434 m^3/kg. The specific internal energy and enthalpy of R-134a at the aforementioned condition are 250.8 kJ/kg and 273.0 kJ/kg, respectively. Given the above information, what is the corresponding pressure of the refrigerant R-134a?

(1) **a)** 0.5 MPa **b)** 0.4 MPa **c)** 0.3 MPa **d)** 0.1 MPa

4) Superheated vapor at 1 MPa, 250°C is contained in a rigid vessel. It is now cooled to 25°C. The final quality (if applicable) of the vessel contents is:

(1) **a)** 0.534% **b)** 2.63% **c)** 27.8% **d)** Not applicable

→ CW.

$x = \frac{0.2327 - 0.001003}{43.36 - 0.001003} = 5.34 \cdot 10^{-3}$

5) i) Is the value of c_p bigger or smaller than c_v for an ideal gas? (1) **a)** bigger **b)** smaller

ii) (1) Write down the expression to determine c_p in term of the specific heat ratio $k = c_p/c_v$ and specific gas constant R_s.

$$c_p = \frac{kR_s}{k-1}$$

6) (1) Again, this one is free if you do not forget to write properly your name and ID number in the space provided on page 1. Don't worry, it is not a tricky question.

7) A frictionless piston-cylinder device initially contains 0.05 m^3 of saturated liquid refrigerant-134a. The piston is free to move, and its mass is such that it maintains a pressure of 500 kPa on the refrigerant. The refrigerant is now heated until its temperature rises to 70 °C. Calculate the specific boundary work done during this process, in kJ/kg.

(1.5/3)

$V_1 = 0.05 m^3$

$P_1 = 500 kPa$

$T_2 = 70°C$

$m = \frac{V_1}{V_2} = 0.95 kg$

C.P. $T_{sat@0.5MPa} = 151.9°C < 70°C$

∴ superheated

$V_2 = 0.05240$

$W_b = W_{1-2} = \int_1^2 P dV = P(V_2 - V_1)$

$= 500(0.05240 - \frac{0.05}{0.95})$

$= 0$

$W_b = 0$ ✗