F06

***25 pts.* Answer the following by circling the correct answer or providing a simple calculation .**

1) (5) Sensible and Latent energy are incorporated in the intensive property (circle correct answer):

(a) enthalpy
(b) internal energy
(d) enthalpy and internal energy
(d) density
(e) specific heat
(f) enthalpy and specific heat

2) (5) The amount of energy absorbed or released *during a phase change* process where steam becomes liquid water can be estimated from:

(a) Specific Heat of Fusion
(b) Specific Heat of Sublimation
(c) Specific Heat of Vaporization
(d) Latent Heat of Fusion
(e) Latent Heat of Sublimation
(f) Latent Heat of Vaporization

3) (5) The phase change process listed above, is always an _______________ process in a closed isobaric process.

(a) isothermal
(b) adiabatic
(c) isolatent
(d) isochoric
(e) isometric
(f) isotropic

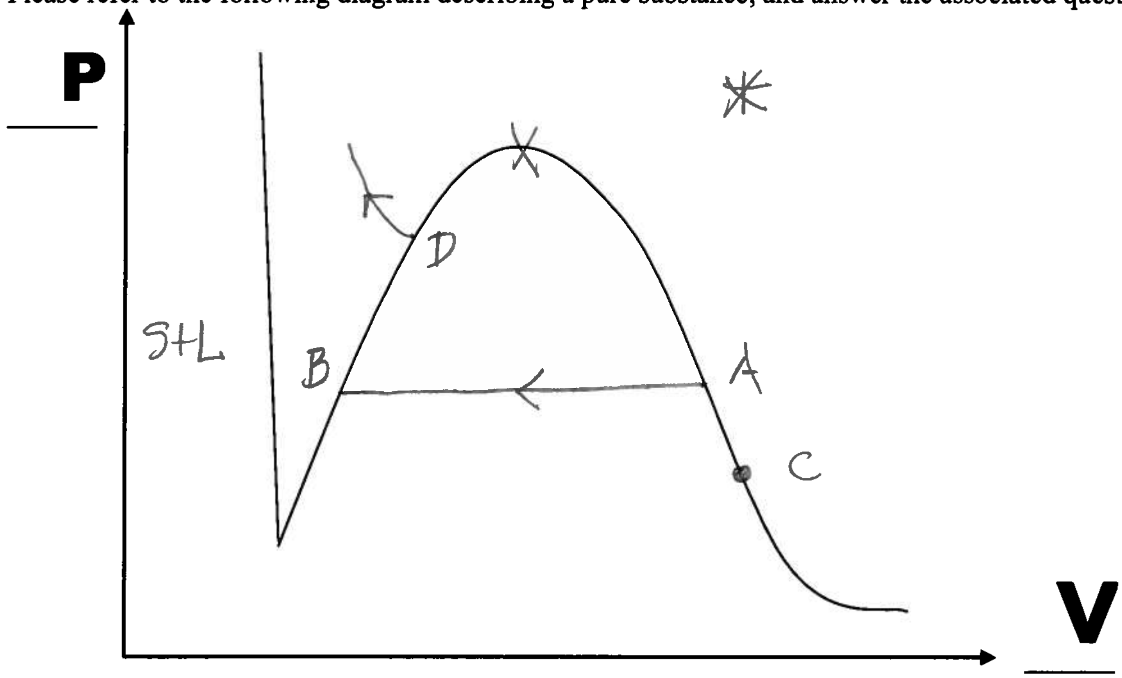
4) (5) If a closed system contains a pure substance with $0 < \text{quality } (X) < 1$, by definition it is:

(a) above its critical point
(b) two phase: liquid + vapor
(c) three phase: liquid + solid + vapor
(d) isothermal
(e) two phase: solid + liquid
(f) none of the choices listed

5) (5) If it takes 5000 J of energy input to raise the temperature of 1kg of a ideal liquid (isolated in a closed system) from 20 C to 30 C, estimate the specific heat of this substance:

$$C_p = \frac{\Delta U}{1kg \cdot \Delta T} = \frac{5 kJ}{1kg\ 10\,^\circ C} = 0.5 \frac{kJ}{kg\,^\circ C}$$

Please refer to the following diagram describing a pure substance, and answer the associated questions:



1) (3) Draw a star (*) in the region where you would likely expect ideal gas behavior

2) (3) Put an X on the critical point

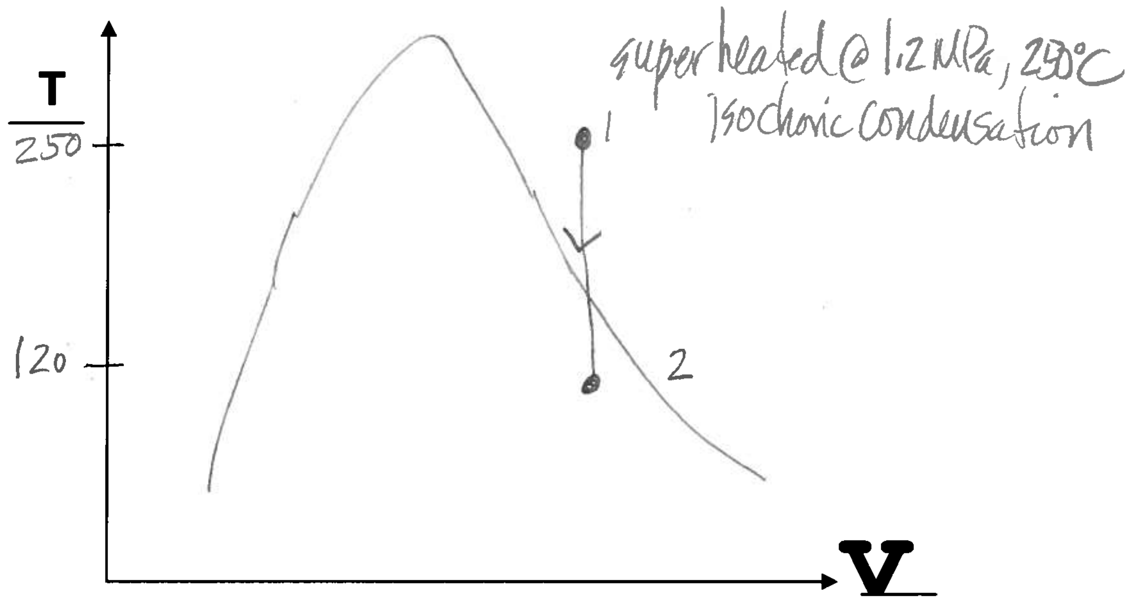
3) (4) Draw the letters **S + L** in the region where a solid and liquid phase exist in equilibrium

4) (5) Draw a line, beginning a point labeled (**A**), and ending with a point labeled (**B**), that would correspond to the path of the complete condensation of a saturated vapor

5) (5) Label any point with a (**C**) that would correspond to a closed system with a 100% quality

6) (5) Pick any point which corresponds to the onset of liquid boiling; label that point (**D**). Show, with an arrow eminating from point **D**, the direction the system would take if pressure increased, but temperature were held constant.

A rigid container initially holds water at 1.2 MPa and 250 C. The container and its contents are allowed to cool to 120 C. **a) (5)** Show this process on a T-v diagram and determine the following:



b) (5) the final pressure

$v_2 = v_1 = 0.19241 \frac{m^3}{kg}$

$v_f < v_2 < v_g$ @ 120°C

∴ mixture

$P = P_s = 198.67 kPa$

c) (5) the system quality

$X = \frac{v - v_f}{v_{fg}}\Big)_{120°}$

$= \frac{0.19241 - 0.00106}{0.89133 - 0.00106}$

$= 0.215$

d) (10) the final specific enthalpy

$h = x h_{fg} + h_f \big)_{120°}$

$= 0.215(2202.1) + 503.81 \frac{kJ}{kg}$

$= 977.12 \frac{kJ}{kg}$

Goodyear designs steel belted tires for trucks, which initially contain 0.5 m^3 of compressed air at 200 kPa. When the trucks are loaded, the tires compress and their effective volumes drop to 0.3 m^3.

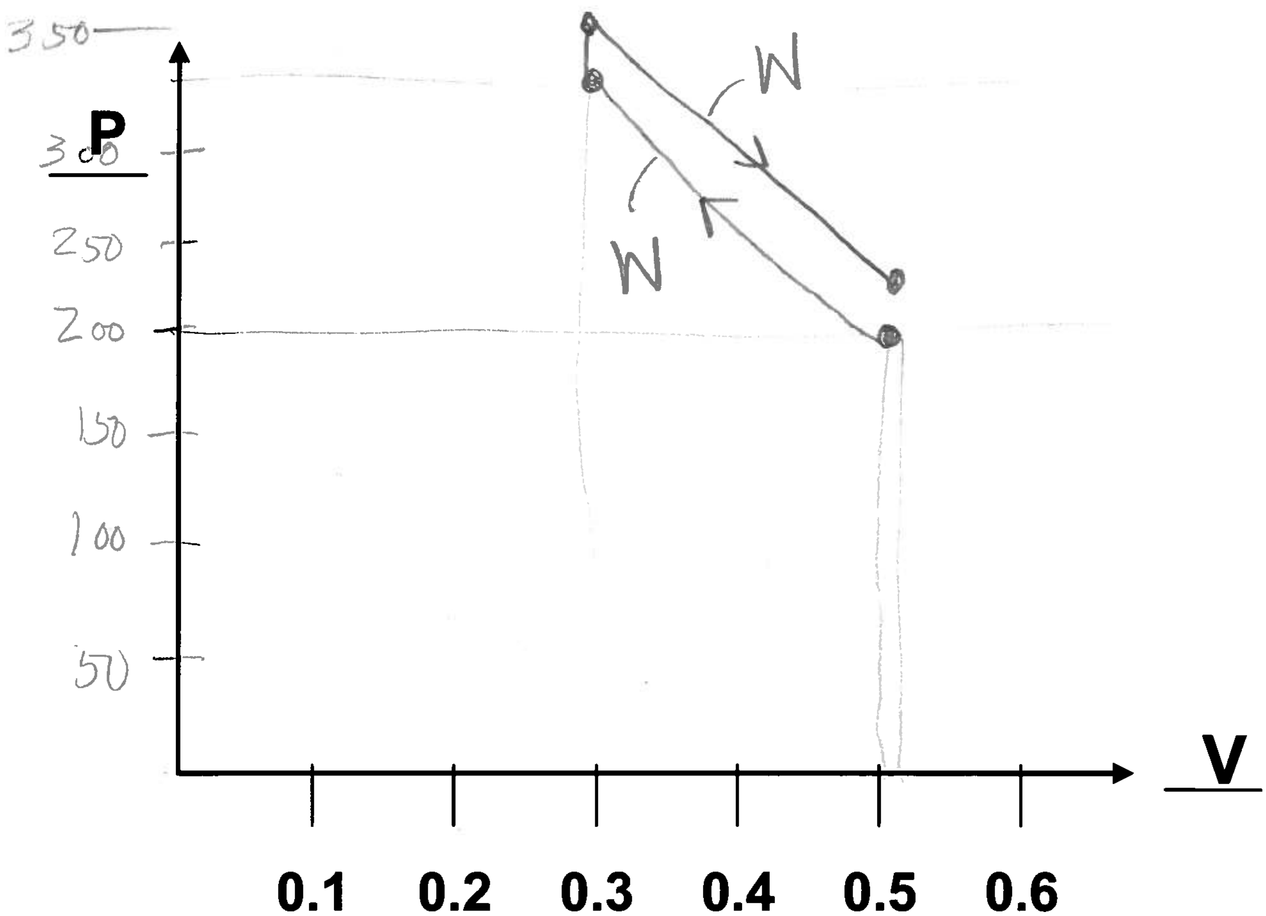
Answer the following questions, and draw the corresponding points and paths on a p-v diagram. Show your work, calculations and assumptions on the following blank page.
Label all the paths where WORK is done on or by the system with a capital W (4 pts)

PATH

1 → 2 Assuming the temperature inside the tire is the same as outside air (30 C), estimate the pressure increase inside the tire under load **(7 pts)**.

2 → 3 Assume the loaded truck moves on hot pavement and the temperature increases from 30C to 46 C; estimate the pressure increase assuming the effective volume of 0.3 m^3 is completely constrained by the steel belts **(10 pts).**

3 → 4 Assume the hot tires are then unloaded at 46 C, and the effective volume rebounds to the original 0.5 m^3 **(4 pts)**



4. unloaded: $V = 0.5\ m^3$, $P = 200\ kPa$

loaded $V = 0.3\ m^3$, $P = ?$

$1 \to 2$ $T = 30°C = 303\ K$

$$P_1 V_1 = P_2 V_2$$

$$P_2 = 200\ kPa \left(\frac{0.5}{0.3}\right) = 333\ kPa$$

$2 \to 3$ $T = 46°C = 319\ K$

$V = 0.3\ m^3$ (const)

$$\frac{P_2}{T_2} = \frac{P_3}{T_3} \qquad P_3 = 333\ kPa \left(\frac{319}{303}\right)$$

$$P_3 = 351\ kPa$$

$3 \to 4$ $V = 0.5\ m^3$

T const.

$$P_4 V_4 = P_3 V_3$$

$$P_4 = 351 \left(\frac{0.3}{0.5}\right) = 210\ kPa$$