

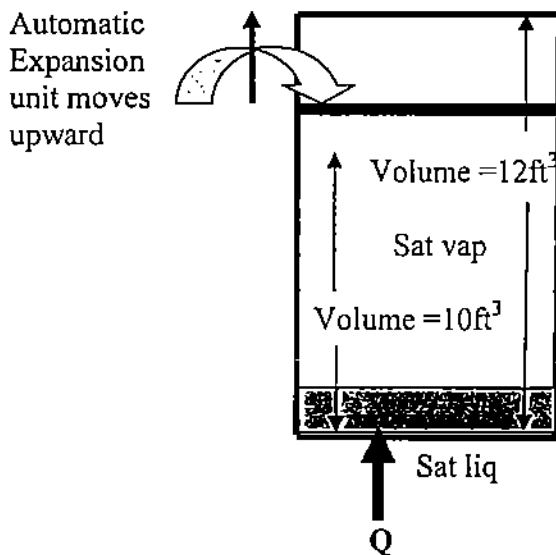
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20041527

**Notre Dame University. Department of Mechanical Engineering**  
**Test #1-MEN210 (Thermodynamic I) Open book part: 50 minutes**  
**Dr. Gabi Nehme. PhD**

**Problem#1**

Heat is transferred to a vessel that is filled with saturated ammonia at 20°C. The vessel has an automatic expansion. It has a volume of 10ft<sup>3</sup> before expansion and contains 2 ft<sup>3</sup> of saturated liquid ammonia and 8ft<sup>3</sup> of saturated vapor ammonia. Heat is transferred until temperature reaches 40°C while pressure stays constant. Also the automatic expansion expands the volume to its fullest 12ft<sup>3</sup>.

Determine the heat transfer for the process. Show all your states. Show a diagram. Explain your model and data.



**Problem#2**

Nitrogen has a compressibility of 0.8 at a pressure of 4 Mpa. Find its specific volume. (Assume the same R in the table).

GOOD LUCK

Final grade

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50

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+

28 = 78

B+

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Question # 1

Explain the triple point and the critical one and show both on two separate diagrams.

Question # 2

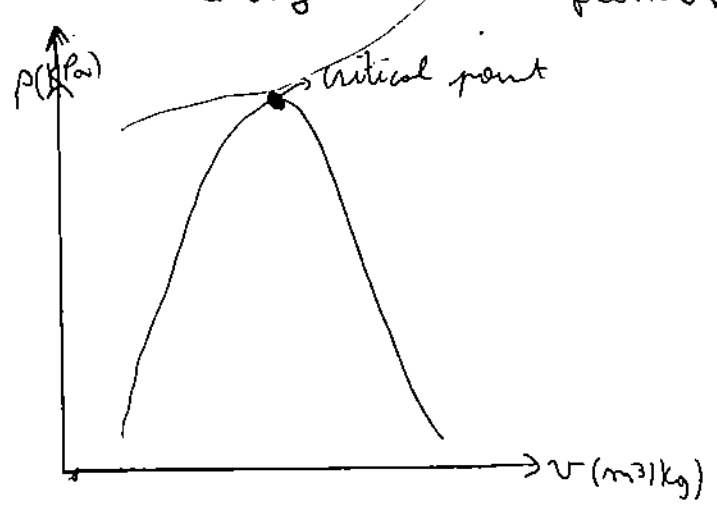
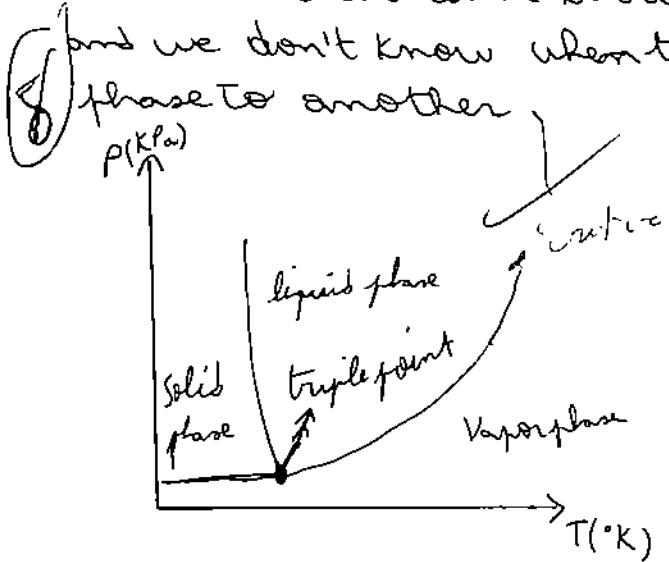
Give a brief description about the refrigeration cycle.

Question # 3

Explain in detail the polytropic process and show all cases.

Question 1:

- The triple point is the only point where there is equilibrium between the solid-liquid and vapor phase. At the triple point the substance exist at the three phases: solid-liquid and vapor.
- The Critical point is the ~~last~~ point where we see both saturated ~~and~~ liquid and vapor phases. Above the critical point we ~~can't~~ don't know what is the phase of the substance and we don't know when the substance changes GOOD LUCK from one phase to another



Question 2:

Refrigeration cycle: The refrigerant enters the compressor as a slightly superheated vapor at low pressure. It then leaves the compressor and enters the condenser as a vapor at high pressure where heat is rejected to the surroundings. The refrigerant leaves the condenser as a saturated liquid. It then enters the expansion valve and leaves as a two-phase mixture. It then enters the evaporator and leaves as a saturated vapor. The cycle repeats.

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condenser as a high pressure liquid ~~and~~ but his pressure is decreased as it flows through the expansion valve where some of the liquid flashes into cold vapor. This low pressure liquid is then evaporated in the evaporator and <sup>then</sup> reenters the compressor  
 show schematic

Question 31

In the polytropic process we have a relation between the pressure and the temperature in the system as  $PV^m = \text{constant}$

~~WORKS~~  $PV^m = \text{cte} \Rightarrow PV_1^m = P_2V_2^m$

$$\Rightarrow P = \frac{P_1V_1^m}{V^m} = \frac{P_2V_2^m}{V^m}$$

(13)

we have 2 different cases in the polytropic process

1- from  $W_2 = \int_1^2 P dV$

$$W_2 = \frac{P_2V_2 - P_1V_1}{1-m}$$

this case works for all "n" except  $m=1$

2- If  $m=1 \Rightarrow W_2 = P_1V_1 \ln \frac{V_2}{V_1}$

the " $\frac{P_2V_2 - P_1V_1}{1-m}$ " and " $P_1V_1 \ln \frac{V_2}{V_1}$ " are not necessarily values for work they are values for a certain integral that can be equal to the work if the work is calculated from  $W_2 = \int_1^2 P dV$ .

I need integration in detail