

## Problem I

(1)

Determine amount of heat rejected

$$\Delta U = Q - W$$

but  $\Delta U = 0 \rightarrow$  isothermal

$$W_{in} = Q_{out}$$

(10)

$$V_1 = \frac{mRT_1}{P_1} = 1.189 \text{ m}^3 \quad (5) \quad ; \quad V_2 = \frac{mRT_2}{P_2} = 0.297 \quad (5)$$

$$W_{in} = P \cdot V \cdot \ln \frac{V_2}{V_1} = -288.6 \text{ kJ}$$

(10)

$$Q_{out} = W_{in} = -288.6 \text{ kJ}$$

## Problem II

$$\varphi_1 = \varphi_g + x \varphi_{fg} \rightarrow \varphi_1 = 0.5952 \text{ m}^3/\text{kg}$$

(5)

$$V_1 = m \varphi_1 = 0.2976 \text{ m}^3$$

a) The mass of the piston

$$m_p g + P_{atm} A_p = P_2 A_p$$

$$A_p = \pi \frac{D^2}{4} = 0.0314 \text{ m}^2$$

$$m_p = \frac{P_2 A_p - P_{atm} A_p}{g} = 0.958 \text{ kg}$$

(10)

b) Determine the total heat and the total work (2)

$$\varphi_{in} = m (h_3 - h_1) \quad (10) \quad \text{since } \varphi_{in} = \Delta U + W \quad \downarrow \quad \text{at } P = \text{const}$$

$$h_3 = h \Big|_{400 \text{ kPa}, 70^\circ \text{C}} = 3927.6 \text{ kJ/kg.} \quad (5)$$

$$h_1 = h \Big|_{P=75 \text{ kPa}, x=0.2681} = 995.2 \text{ kJ/kg.} \quad (5)$$

$$\varphi_{in} = 1466.2 \text{ kJ} \quad (5)$$

$$W_{out} = m \overset{400 \text{ kPa.}}{\underset{\downarrow}{P}} (u_3 - u_2) \quad (10)$$
$$= 105.26 \text{ kJ}$$

### Problem II)

1)  $P_R \ll 1$  or  $P_R < 10$  and  $T_R > 2$  (5)

2) for isochoric processes. (5)

3) the variation in enthalpy (5)

4) Bose-Einstein condensate. (5)