Problem I

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Leftrightarrow V_2 = \left(\frac{T_2}{P_2}\right) \frac{P_1 V_1}{T_1}$$

$V_2 = 29.73\ m^3$ (10)

Problem II

1/ Yes, since $P_R < 10$ and $T_R > 2$ (5)

. No, it is a liquide under such conditions (5)

2/ $X \simeq 0.42$ for $T = 120°C$ $V_L = 2L$ (5)
$V_{vap} = 1200L$

3/ $V = 90 \times 1000 / 3600 = 25\ m/s$

we have: $F_D = \frac{1}{2} \rho V^2 A C_D$ (10)

$= 0.5\ 1.23\ 25^2\ 2.3\ 0.3$

$= 265\ N$

$W = F_D . V = 265 \times 25 = 6630\ W$

4/ We have by definition

$$h = U + Pv \iff dh = dU + d(Pv)$$

(5)

for an ideal gas $Pv = RT$

then $dh = dU + d(RT) \iff dh = dU + R\,dT$

$$\Rightarrow \underbrace{\frac{dh}{dT}}_{C_p} = \underbrace{\frac{dU}{dT}}_{C_v} + R$$

Then $C_p - C_v = R$

PRoBlem III

a/ $W = \int_1^2 P\,dV = P\int_1^2 dV = P(V_2 - V_1)$

$= 200\,(0.1 - 0.04)$

$= 12$ kJ (10)

b/ $W = \int_1^2 P\,dV = P_1 V_1 \ln \frac{V_2}{V_1}$

$= 200 \; 0.04 \; \ln \frac{0.1}{0.04}$

$= 7.33$ kJ (10)

3/ we have: $PV^n = ct$

So $W = \int_1^2 P\,dV = \int_1^2 \frac{ct}{V^n}\,dV$

$= ct \int_1^2 \frac{dV}{V^n} = ct\left(\frac{V_2^{1-n} - V_1^{1-n}}{1-n}\right)$

with $n \neq 1$

but $ct = P_1 V_1^n = P_2 V_2^n$

So $W = \frac{P_2 V_2 - P_1 V_1}{1-n}$ (10)

with $P_2 = P_1\left(\frac{V_1}{V_2}\right)^n \Leftrightarrow P_2 = 200\left(\frac{0{,}04}{0{,}1}\right)^{1{,}3}$

$W =$

$P_2 = 60{,}77$ kPa (10)

Then $W = 6{,}41$ kJ (10)

4/ $W = 0$ since $dV = 0$ (10)