Thermodynamics MEN210A **Review Quiz One** **Oct 30, 2006**
8-9 MWF **Instructor: W. Assaf**

$R = \frac{8.314}{28.013} = 0.2968$

Problem One

$pv = mRT$ $\quad m = \frac{pV}{RT} = \frac{(1000\ kN/m^2)(1\ m^3)}{(0.2968\ kJ/kg\,K)(293\ K)} = 11.5\ kg$

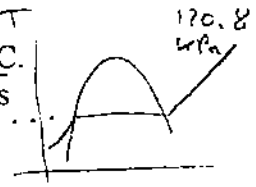
(a) Find the mass of Nitrogen, treated as ideal gas, trapped in a box having a volume of one cubic meters at 1000 kPa and 20°C.

(b) Go to page 656, find the critical constants of N_2 and calculate the value of Z by reading the compressibility chart on page 728. Was the assumption of ideal gas in part (a) above a correct one to make? $P_c = 3.39\ MPa$ $T_c = 126.2\ K$

$P_r = \frac{1}{3.39} = .295$ $\quad T_r = \frac{293}{126} = 2.32$ $\quad Z \cong 1$ yes

Problem Two

Water in a 15 cm diameter stainless steel pressure cooker is expected to boil at 105°C. How heavy should the lid covering this pressure cooker be? Atmospheric pressure is 101 kPa.



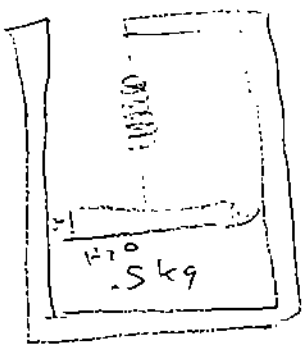
$Area = \frac{\pi D^2}{4} = \frac{(3.14)(.15)^2}{4} = .0176625\ m^2$

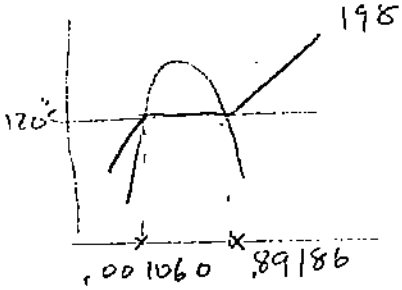
$(120.8 - 101)(.0176625\ m^2) = 0.350\ kN = (m)(9.81\ m/sec^2)$

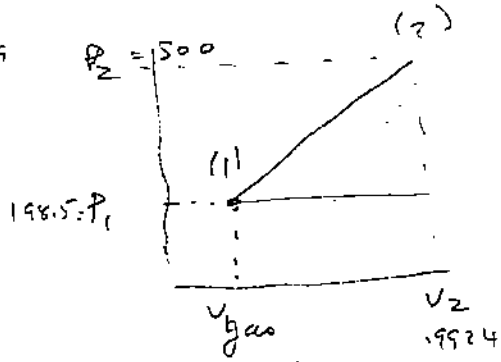
$m_{lid} = \frac{35.6}{9.81} \times 1000 = 35.6\ kg$ (?)

Problem Three

A cylinder having a piston restrained by a linear spring with spring k = 15 kN/m contains 0.5 kg of saturated water vapor at 120°C. Heat is transferred to the water causing the piston to rise. The piston cross sectional area is 0.05 m^2 and the pressure varies linearly with volume until a final pressure of 500 kPa is reached. What is the final temperature of the system?







Volume (1) $= (.5\ kg)(.89186\ m^3/kg) = 0.44593$

$P_2 = P_1 + \frac{k\,\Delta x}{A}$ $\quad \Delta x = \frac{\Delta V}{A}$

$P_2 = P_1 + k\frac{\Delta V}{A^2}$

$500 = 198.5 + \frac{(15)(V_2 - .89186)\ m}{(.05)^2}$

$.05025 = (V_2 - .89186)(.5\ kg)$

$.1005 = V_2 - .89186$

$V_2 = .9924$

look for $V_2 = .9924$, $P_2 = 500\ kPa$

$T_2 \cong 803°C$

$W_{1\to2} = \frac{(P_1+P_2)}{2}(m)(\Delta V) = 17.56\ kJ$