MET 350 HW 3.3

13.30

$CO_2: \frac{P_{CO_2}}{P_t} = 20/100 = .2$ $\quad P_{total} = O_2 + CO_2 + N_2 = 100 kPa$

$O_2: \frac{P_{O_2}}{P_t} = 30/100 = .3$

$N_2: \frac{P_{N_2}}{P_t} = 50/100 = .5$

$m_{CO_2} = NM = (20 kmol)(44 kg/kmol) = 880 kg$

$m_{O_2} = (30 kmol)(32 kg/kmol) = 960 kg$

$m_{N_2} = (50 kmol)(28 kg/kmol) = 1400 kg$

total mass = 1400 + 960 + 880 = 3240 kg

Mass fractions $\quad mf_{O_2} = \frac{m_{O_2}}{m} = 960/3240 = .2963$

$CO_2 = 880/3240 = .2761$

$N_2 = 1400/3240 = .4321$

$Mm = 3240/100 = 32.4 kg/kmol$

Constant volume → $\quad C_v = mf_{O_2} C_{O_2} + (for\ O_2) + (for\ N_2)$

$C_v = (.2716 \times .657) + (.2963 \times .658) + (.4321 \times .743)$

$C_v = .69 \ kJ/kgK$

Gas Constant = $R = R_u/Mm = .256 kJ/kgK$

$C_p = C_v + R = .951 kJ/kgK$

$k = C_p/C_v = 1.376$

13-39

15% CH_4
85% Air

$y_{air} = 1 - y_{CH_4} = .85$

$m_m = .15(M_{CH_4}) + .85(M_{air})$

$m_m = .15(16) + .85(28.97)$

$m_m = 27.02$ g/mol

$V = \frac{\nu d}{2} = \frac{(3000)(.005)}{2 rev/s} = 7.5$ m³/mm

$v = \frac{RuT}{MmP} = \frac{(8.314)(293)}{27.02 * 80} = 1.127$ m³/kg

$m = V/v = 7.5/1.217 =$ **6.65 kg/mm**

13-54

	molar mass	specific H
NG	20.18	.6179
Ar	39.95	.3122

Mole Number : $N_{NG} = \frac{PV_1}{RT_1} = \frac{(100 kpa)(.45)}{(8.314)(293)} = .0185$ kmol

$N_{AR} = \frac{(200)(.45)}{(8.314)(323)} = .0353$ kmol

$N_t = .0520$ kmol

A)

$E_m - E_{out} = \Delta E_{system} \longrightarrow -Q_{out} = \Delta U = \Delta U_{NG} + \Delta U_{AR}$

$-Q_{out} = (m c_v (T_m - T_1))_{NG} + (m c_v (T_m - T_1))_{AR}$

$T_m =$ **16.2°C**

B) $P_m = \frac{N_m R_u T_m}{V_m} = \frac{(.052)(8.314)(289.2)}{.9 m^3} =$ **138.9 kpa**

13.59

	Molar Mass	mole number	
CH_4	16.0	$60/16 = 3.75$ kmol	$N_{Mtotal} = 4.57$ kmol
C_3H_8	44.0	$25/44 = .5682$ kmol	
C_4H_{10}	58.0	$15/58 = .2586$ kmol	$Mm = 100/4.57 = 21.88$ kg/kmol

$R = Ru/Mm = 8.314/21.88 = .3805$ kg/kmol

$wm = RT \ln(P_2/P_1) = \boxed{287 \text{ kJ/kg}}$ (computed via desmos)

$Em = Eout$ therefore $wm = q_{out}$ $q_{out} = 287$

therefore $\boxed{wm = 287 \text{ kj/kg}}$