Question Number IV *(15 Marks ~ 27 minutes)*

Use the data below to answer the following questions.

	MW (g/mol)	T (ºC)	P_v (kPa)	ΔHv (kJ/kg)
Propane	44.09	27	1013	332.5
n-Pentane	72.15	10	37.8	-
		50	159.1	-

a) Obtain vapour pressure correlations of the form ln(Pv)=-A/T+C (with Pv in kPa and T in K) for pure propane and pure n-pentane from the above data. *(/4)*
b) Determine the normal boiling points of pure propane and pure n-pentane. *(/2)*
c) Estimate the heat of vaporization of n-pentane. *(/2)*
d) Mixtures of propane and n-pentane can be assumed to obey Raoult's law. A vapour mixture, comprising 60 mol% propane and 40 mol% n-pentane is at its dew-point temperature of 30ºC. Estimate the dew-point pressure and the corresponding liquid phase composition. *(/5)*
e) Briefly answer the following questions.
   i. In Experiment 3 of the ENGG 201 Laboratory, an isoteniscope containing isopropanol was used to measure vapour pressure of a liquid. How can air be removed from the liquid? *(/1)*
   ii. In Experiment 2 of the ENGG 201 Laboratory, isotherms were collected for Freon. Give one reason why the pressure did not stay constant when 2 phases (liquid and vapour) were present. *(/1)*

*a) Propane A=ΔHv/R → ΔHv = 332.5 kJ/kg * 44.09 kg/kmol = 14659.9 kJ/kmol*
A = 14659.9 kJ/kmol / 8.314 kJ/kmolK = $\underline{1763.3\ K^{-1}}$
Sub in given Pv data → ln(1013)=-1763.3/300+C → $\underline{C=12.80}$

n-pentane $\ln\left(\frac{P_2}{P_1}\right)=\frac{\Delta Hv}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$ *→ ln(159.1/37.8) =ΔHv/R (1/283-1/323)*

ΔHv/R = 3284.4 K^{-1}
Sub in one of the points:
ln(P)-ln(37.8) = 3284.4 K^{-1} (1/283 – 1/T)
ln(P) = -3284.4 / T + 15.24
$\underline{A = 3284.4\ K^{-1},\ \ C = 15.24}$

b) Sub P = 101.325 kPa into each formula derived above and solve for T
$\underline{Tn_{(prop)} = 215\ K}$ $\underline{Tn_{(pent)} = 309.2\ K}$

c) From a) ΔHv/R = 3284.4 K^{-1} so <u>ΔHv=27306 kJ/kmol OR 378.46 kJ/kg</u>

d) vapour y_1=0.60, y_2=0.40 T=303K → Do a sum of x_i to get P where $x_i=(P*y_i)/Pv_i$
First need Pv_1 and Pv_2 at T=303K → use results from a)
ln(Pv_1)=-1763.3/303+12.8 → Pv_1=1075kPa
ln(Pv_2)=-3284.4/303+15.24 → Pv_2=81.48kPa

So $P = 1/[y_1/Pv_1+y_2/Pv_2] = 1/[0.6/1075+0.4/81.48] = \underline{182.91kPa}$

Now, $x_1=(P*y_1)/Pv_1=182.91*.6/1075 = \underline{0.102}$

$x_2=(P*y_2)/Pv_2=182.91*.4/81.48 = \underline{0.898}$

e) i) decrease the pressure a few times (Maen you may have a more accurate answer)
ii) not enough time to reach true equilibrium