winter 1997 (Final) Ch. 7

1000 kg of liquid n-hexane (C_6H_{14}) at 20°C and 1 Atm

a) Get this information from Table 7-3 and 7-4 pg 215 & 217 in you textbook

$H_v = 31.74 \times 10^3$ kJ/Kmol

$C_{P(L)} = 2.51 \frac{KJ}{Kg\,K}$ $\quad C_{P(v)} = 1.823 \frac{KJ}{Kg\,K}$

b) see table 7-5: normal BP for n-hexane = 68.74°C

$\Delta H_v = 29.05 \times 10^3 \frac{KJ}{Kmol}$ at 68.74°C

$P_v(68.74°C) = 101.325$ kPa

$$\ln(101.325) = -\frac{29{,}050 \text{ KJ/Kmol}}{8.314 \frac{KJ}{Kmol \cdot K}(293.15K)} + C_o$$

$\ln(101.325) = 4.6183$

$C_o = 16.54$

$$\ln(P) = -\frac{3494}{T} + 16.54$$ where P is in kPa and T is in K

c) $Q = m(C_{PL})(T_{BP} - T)$

$Q = 1000\text{kg}\left(2.51 \frac{KJ}{Kg\,K}\right)(68.74°C - 20°C)\left(\frac{1°K}{1°C}\right)$

or $(341.89K - 293.15K)$

$\boxed{Q = 122{,}337.4 \text{ KJ}}$

d) $Q = m C_{PL}(T_{BP} - T_1) + m\Delta H_v + m C_{Pv}(T_2 - T_{BP})$

$Q = 1000\left(2.51 \frac{KJ}{Kg\,K}\right)(68.74 - 20) + \frac{1000}{86.18 \frac{Kg}{Kmol}}\left(29050 \frac{KJ}{Kmol}\right) + 1000(1.823)(100 - 68.74)$

$\boxed{Q = 516{,}409.6 \text{ kJ}}$

Winter 1997 (Final) Ch. 7 continued

e) $Q = \frac{Q}{2} = \frac{516,409.6\ kJ}{2} = 258,204.8\ kJ$

$$Q = mC_{P_L}(T_{BP} - T_1) + \frac{m}{M}\Delta H_v$$

$$258,204.8 = 1000\,kg\left(2.51\ \frac{kJ}{kg\,K}\right)(68.74 - 20) + \frac{m}{86.18\ kg/kmol}(29,050)$$

$m_V = 403\ kg$

since at liquid vapor equilibrium, $\boxed{T = 68.74°C}$

mass of vapour = 403 kg

mass of liquid = 1000 − 403 = 597 kg

$$\text{Liquid} = \frac{597}{1000} = \boxed{0.597}$$