4) Solid or Liquid. @ T_{melt}: $H_L/\text{atom} - H_S/\text{atom} = 4\times10^{-22}$ J

$\dfrac{S_L - S_S}{\text{atom}} = 6\times10^{-24}$ J/K

1. $L = ?$ J/mol

$\mu_S = \mu_L$ $G_S = G_L$

$L = \Delta U + p\Delta V = Q$

$H = U + pV$

$S = k\ln\Omega$

$U_S - T_S S_S + p_S V_S = U_L - T_L S_L + p_L V_L$ $T_L = T_S$: Melting pt

$T_L S_L - T_S S_S = H_L - H_S$

$T_m (S_L - S_S) = H_L - H_S$

$T_m \approx 66.67\ ^\circ K$

$\boxed{2.\ T_m \approx 66.67\ ^\circ K}$

$L = U_L - U_S + p(V_L - V_S) = U_L + pV_L - U_S - pV_S = H_L - H_S = 4\times10^{-22}$ J/atom

$(H_L - H_S)\cdot N_A \approx \boxed{240.88 \text{ J/mol}}$

5) P

$p = 1\text{atm} = 101325$ Pa $T = 373.15$ K Add Q, it all

(boiling point) becomes vapor

$m = 114$g

$mol_w = 18$g/mol $L = 2260$ J/g

1) Q to boil?

$L\cdot m = 2260\dfrac{J}{g}\cdot 114g = \boxed{257640 \text{ J}}$

2) $V_L \approx 0$ $V_g = V_f$ Ideal gas, p is constant

$pV = NkT$ $W_{by} = \int p\,dV$

$V_f = \dfrac{NkT}{p} = \dfrac{6.3N_A k(373.15)}{101325} \approx 0.1938$ $= \int_0^{0.1938} 101325\,dV$

$\approx \boxed{19639.7 \text{ J}}$

3) $\Delta U_L = ?$

$dU = dQ - pdV$

$= 257640 - W_{by g} \approx \boxed{238000 \text{ J}}$

HW 10: Ideal Solutions

1) oil $T = 283$K $\Delta E = 2.208\times10^{-20}$ J/molecule

water $\dfrac{N_w}{N_{oil}} = 9\times10^{-4}$ ← concentration

Vant Hoff. $\ln\left(\dfrac{k_2}{k_1}\right) = \dfrac{\Delta E/\text{mol}}{R}\left(\dfrac{1}{T_1} - \dfrac{1}{T_2}\right)$

$\dfrac{N_w}{N_{oil}}$ @ $T = 293$K

$\dfrac{k_2}{k_1} \approx 1.213$ $k_2 = 1.213\,k_1 \approx \boxed{10.915\times10^{-4}}$ water

2) $T = 283$ K $k_1 = 0.9$g/L

$T = 293$ K $k_2 = 1.092$ g/L

1. $\Delta E = 2.208\times10^{-20}$ J/molecule

2. Solubility @ $T = 327$K?

$k_2 = k_1 e^{\left(\frac{2.208\times10^{-20} \text{ J/molecule}\cdot\frac{1g}{1L}\cdot N_A}{R}\left(\frac{1}{283} - \frac{1}{327}\right)\right)}$

$k_2 \approx 2.1396\cdot 0.9 \approx \boxed{1.925 \text{ g/L}}$

1) $T_i = 0°C$ $\quad T_f = 100°C$ $\quad L_{melt} = 333.5\ J/g$ $\quad L_{boil} = 2257\ J/g$

1. Q to melt 1 kg ice? $\quad L \cdot m = 33.5 \frac{J}{g} \cdot 1000g = \boxed{333500\ J}$

2. $S_{liq} - S_{ice} = ?$

$$\Delta S = \int \frac{dQ}{T} = \frac{\Delta Q}{T} = \frac{333500\ J}{273.15K} \approx \boxed{1220.94\ J/K}$$

3. $S_{gas} - S_{liq} = ?$

$$\Delta S = \frac{\Delta Q}{T} = \frac{L_{boil} \cdot 1000}{273.15 + 100} \approx \boxed{6048.5\ J/K}$$

4. $C_{v_{water}} = 4184 \frac{J}{kg \cdot K}$
Ignore ΔV

$$\Delta S = \int \frac{1}{T} dU \qquad c = \frac{dU}{dT} \Rightarrow \Delta S = \int \frac{c}{T} dT$$

$$\Delta S = \int_{273.15}^{373.15} 4184\left(\frac{1}{T}\right) dT = 4184 \ln(T)\Big|_{273.15}^{373.15} = 4184 \ln\left(\frac{373.15}{273.15}\right) \approx \boxed{1305.2\ J/K}$$

2) Water:
$m = 10\ kg$ $\quad T_i = 373.15\ K$ $\quad L_{l \to g} = 2230\ J/g$ $\quad m = 18 g/mol$
$p = 101325\ Pa$ (boil at this pressure) $\quad \Delta Q = 10^3\ J$

1. mass (vapor) = ?

$L = 2230000 \frac{J}{kg}$ $\qquad L \cdot 10kg = 2230 \times 10^3\ J$ to boil 1 kg

$$\frac{10^3}{2230 \times 10^3} \approx \boxed{0.448g}$$

2. $\Delta G = ?$

$$G = U - TS + pV \qquad V = \frac{NkT}{P}$$

$$dG = dU - TdS - \cancel{SdT} + pdV + \cancel{Vdp}$$

$$= dU - dQ = 0$$

$$\Delta G = \Delta U + p\Delta V - T\Delta S = \boxed{0}$$

3. $\Delta S = ?$

$$dS = \frac{dQ}{T} \rightarrow \Delta S = \frac{\Delta Q}{T} = \frac{10^3}{373.15} \approx \boxed{2.68\ J/K}$$

4. $\Delta H = ?$

Enthalpy $\rightarrow H = U + pV \qquad dH = dU + pdV + \cancel{Vdp} = dU + Nk\,dT$

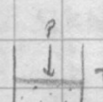
$$dU = dQ + pdV \qquad dH = dQ + \cancel{2Nk\,dT} \qquad \boxed{\Delta H = 10^3\ J}$$

5. $\Delta V = ?$

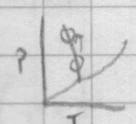
$$V_i = 0 \qquad pV = NkT \qquad V_f = \frac{NkT_f}{p} = \frac{\frac{mass(vapor)}{18g/mol} \cdot RT}{P} \approx \boxed{7.65E-4\ m^3}$$

6. $\Delta U_{TOT} = ?$

$$\Delta H = \Delta U + p\Delta V \qquad \Delta U = \Delta H - p\Delta V \approx \boxed{922.46\ J}$$

3) 
$p_i = 1atm$
Δp to lower T_{boil} by 1°C? $\qquad L_B = 2.256 \times 10^6\ J/kg$

At boiling pt: $\mu_g = \mu_l \qquad \mu = \frac{G}{N} \qquad G = U - TS + pV \qquad dU = dQ + pdV$



$$\frac{d(\mu_g - \mu_l)}{dT} = \frac{d(\mu_g - \mu_l)}{dp} \qquad \mu = \frac{1}{N}(U - TS + NkT) \qquad dU + pdV$$

$$d\mu = \frac{1}{N}(dQ + pdV - TdS - SdT)$$

$$\frac{d\mu}{dp} = V/N$$

$$\frac{(S_G - S_L)}{N} = \frac{L_B}{T} \cdot \frac{m_W}{N_A} \qquad \frac{V_g - V_l}{N} = kT/p \qquad \Delta p = \frac{L_B}{T} \cdot \frac{m_W}{N_A} \cdot \frac{P}{kT} \cdot \Delta T$$

$$\boxed{\approx -3555\ Pa}$$