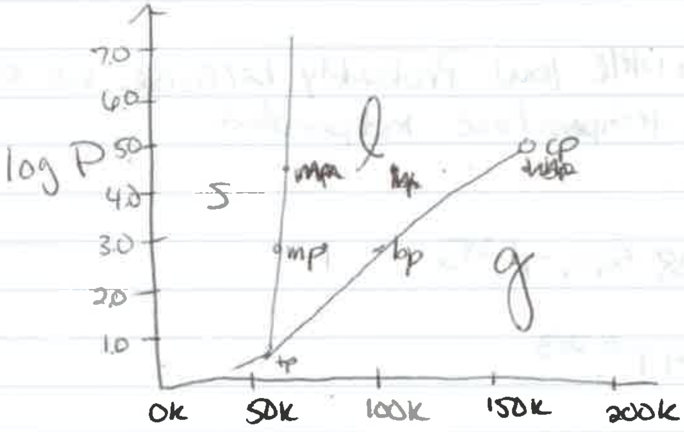
HWK #5 Key

1. Phase diagram for O_2

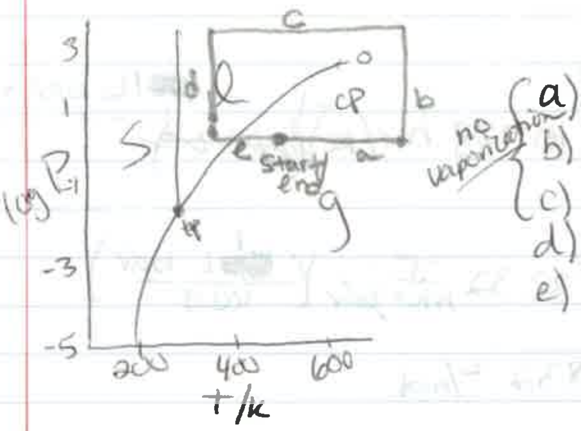
Triple pt : 54.3 K and 1.14 torr ($\log P = 0.569$)
Critical pt : 154.6 K and 37828 torr ($\log P = 4.58$)
normal mp : 54.75 K and 760 torr ($\log P = 2.88$)
normal bp : 90.25 K and 760 torr ($\log P = 2.88$)



side note
No oxygen doesn't melt with applied pressure.
-the solid-liquid coexistence curve has a positive slope (like benzene not H_2O).

2. Copy of Fig 23.5

$1\text{ atm} \Rightarrow \overset{\log P}{\log(1)} = 0$
$500\text{ atm} \Rightarrow \log(500) = 2.699$



no vaporization
a) start as gas, end as hotter gas
b) move into supercritical phase
c) cool from supercritical phase to liquid phase
d) stay in liquid phase but @ reduced pressure
e) end at beginning pt (gas)... vaporization observed

3. Clausius-Clapeyron Equation

$$\ln P_2/P_1 = \frac{-\Delta_{vap}H}{R}\left(\frac{1}{T_2}-\frac{1}{T_1}\right)$$

normal = 1 atm
n bp of H_2O = 100°C = 373K
110°C = 383K

$$\ln P_2/1\text{ atm} = \frac{-40650\ \text{J/mol}}{8.314\ \frac{J}{mol K}}\left(\frac{1}{383K}-\frac{1}{373K}\right)$$

$$P_2 = e^{0.342} = 1.41 \text{ atm or } 1070 \text{ torr}$$

Our value is a little low. Probably because we assumed $\Delta_{vap}H$ was temperature independent.

4. $P = -718 + 2.38545T^{1.283}$

$$\frac{dP}{dT} = 3.06079T^{0.283}$$

$$\frac{dP}{dT} @ 85.46 K = 10.778 \text{ bar/K}$$

$$\frac{dP}{dT} = \frac{\Delta\bar{H}}{T\Delta\bar{V}}$$

$$\Delta\bar{V} = \frac{\Delta\bar{H}}{T}\cdot\left(\frac{dP}{dT}\right)^{-1}$$

$$= \frac{35300\ \text{J/mol}}{85.46\ \cancel{K}}\left(10.778\ \text{bar}/\cancel{K}\right)^{-1}$$

$$\boxed{1 L\cdot bar = 100J}$$

$$= \left(38.32\ \frac{\cancel{J}}{mol\ \cancel{bar}}\right)\left(\frac{1\ L\cdot \cancel{bar}}{100\ \cancel{J}}\right)$$

$$= 0.3832\ \text{L/mol}$$

5. See attached Excel sheet

$\Delta_{vap}H = \Delta H_g - \Delta H_l = 47.8100 - 12.5509 = 35.2591$ kJ/mol