

Phys 335: Problem 5.24

Diamond & Graphite which is more stable?
1 mole @ STP (table, pg. 404)

Substance	$\Delta_f G$ (kJ)	S (J/K)	V (cm ³)
Graphite	0	5.74	5.30
Diamond	2.900	2.38	3.42

Recall at const T, p , & $G \rightarrow$ minimize

$$G = U - TS + pV$$

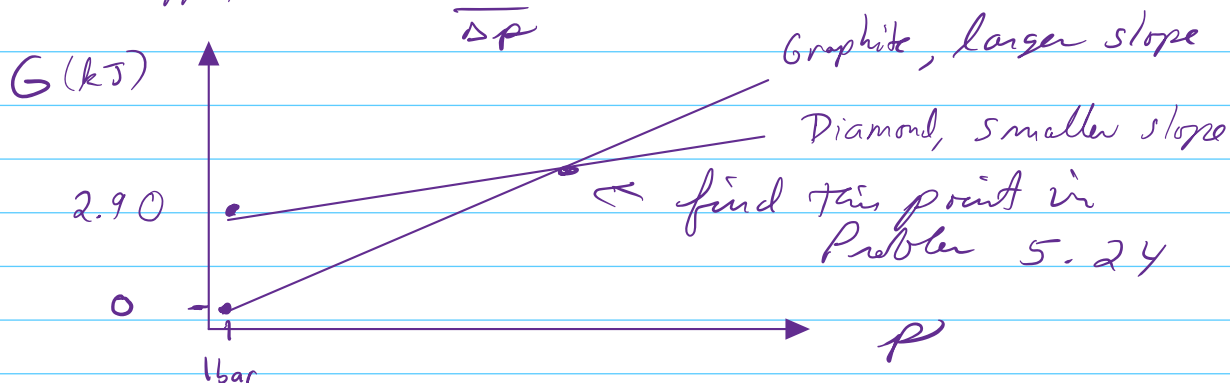
$$dG = dU - TdS + p dV + V dp$$

$$dG = -SdT + Vdp + \mu dN$$

What if you increase the pressure? Recall

$$V = \left. \frac{\partial G}{\partial p} \right|_{T, N}$$

So approximate $\frac{\Delta G}{\Delta p} \approx V = \text{slope}$



$$G_g = 0 + V_g \cdot \Delta p \quad (\text{graphite})$$

$$G_d = 2.90 + V_d \cdot \Delta p \quad (\text{diamond})$$

When does $G_g = G_d$?

$$0 + V_g \cdot \Delta p = 2.90 + V_d \Delta p$$

$$\Delta p (V_g - V_d) = 2.90 \text{ kJ}$$

The units are odd ; convert to Pa.

$$\Delta p = \frac{2.90 \times 10^3 \text{ J}}{(5.30 - 3.42) \text{ cm}^3} \times \left(\frac{100 \text{ cm}}{1 \text{ m}} \right)^3 = 1.54 \times 10^9 \text{ Pa}$$

$$\Delta p = 1.54 \times 10^9 \text{ Pa} \times \frac{1 \text{ bar}}{10^5 \text{ Pa}} \times \frac{1 \text{ kbar}}{10^3 \text{ bar}} = 15.4 \text{ kbar}$$