Problem Set 9 Solutions

1. See Problem 5 in Problem Set 8 Solutions.

3a. Assuming Random Walk $< R^2 >= nl^2$

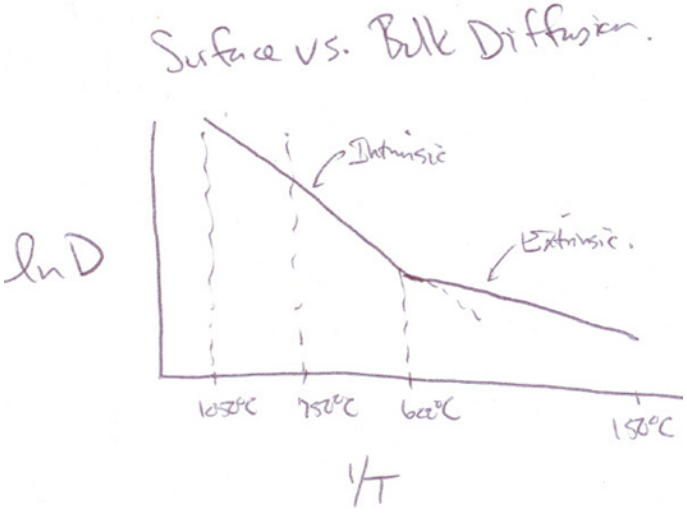
3b. In general $< R^2 >= nl^2 f$

i). $< R^2 >= nl^2 \Rightarrow f = 1$. Random Walk. Jumps not correlated.

ii). $< R^2 >= 0 \Rightarrow f = 0 \Rightarrow$ Jumps *completely* correlated.

iii). $nl^2 << R^2 > n^2 l^2 \ldots f > 1$. Future jumps are biased by prior jumps.

4.



Diffusion mechanism is temperature dependent. At 150°, you are in extrinsic rather than intrinsic regime. Grain boundaries, defects increase rate of diffusion.

5.

$$\Delta g_b = -2000\text{J/mol}$$

$$\gamma = 100\text{mJ/m}^2$$

$$\Gamma_c = \frac{-2\gamma}{\Delta g_B}$$

$$\Delta g_B = -2000\text{J/mol} \times \frac{1\text{mole}}{6.02 \times 10^{23}\text{atoms}} \times \frac{4\text{atoms}}{1 \text{ unit cell}} \times \frac{1 \text{ unit cell}}{(3.8 \times 10^{-10})^3} = -2.42 \times 10^8 \text{J/m}^3$$

$$\Gamma_c = \frac{-2(100 \times 10^{-3})}{-2.42 \times 10^8 \text{J/m}^3} = 8.3 \times 10^{-10}\text{m}$$

$$\Delta G_c = \frac{16\pi\gamma^3}{3\Delta g_B^2} = 2.9 \times 10^{-19}\text{J}$$

$$\#\text{ Atoms} = 4 \times \left[\frac{\frac{4}{3}\pi\Gamma_c^3}{a^3}\right] = 174 \text{ atoms}$$

$$\Delta G_c = 2.9 \times 10^{-19}\text{J}$$

$$kT = 1.38 \times 10^{-23} \times 800 = 1.1 \times 10^{-20}$$

$$76kT = 8.4 \times 10^{-19}\text{J [@800K]}$$

$\Delta G_c \approx 26.4kT < 76kT$, Nucleation is likely observable.