

3.40J/22.71J Physical Metallurgy
Mid-Term Examination
1.5 hours

Closed Book, Closed Notes, except one, 8.5"x11" Spike sheet.

$R = 8.3 \text{ J/mole K} = 1.98 \text{ cal/mole K}$. $k = 1.38 \times 10^{-23} \text{ J/K}$

Do all four problems, which are weighted equally. Show all your work and justify all assumptions and approximations. This exam is to be written in your choice of ink, except disappearing ink

1. Cold-worked, commercial purity metals undergo recovery at about $T_m/4$ and recrystallization at about $T_m/2$, where T_m = absolute melting temperature.
 - a. Describe very briefly what are meant by recovery and recrystallization.
 - b. Metals of high purity anneal at much lower temperatures. Explain why this is so, using an equation or two.
2. Some alloys, including ordinary structural steel display an upper and lower yield point.
 - a. Sketch a stress-strain curve for such an alloy and indicate the upper and lower yield points.
 - b. Give, and briefly explain, two ways in which the double yield point phenomenon may be eliminated.
3. Nickel is FCC with a lattice constant of $3.5 \times 10^{-10} \text{ m}$. A simple tilt boundary with a dislocation-dislocation spacing of 10^{-8} m is observed. What is the misorientation angle of the boundary?
4. Write a brief essay on the effects of second phase particles on grain growth in annealing. Use some equations and explain what they describe and their strengths and limitations.