University of Portland
EGR 221 - Materials Science
Exam 2 (CLOSED BOOK, CLOSED NOTES)
November 1, 2013, Dr. Ken Lulay

**FOR 2015, green questions are not relevant for exam 3.**

Name_____ (Exam version: b)

1) **{15 pts} Answer true (T) or false (F):**

   T    F    The recrystallization temperature of a metal is approximately one-half its melting point. The melting point of aluminum is 660°C; therefore, the recrystallization temperature of aluminum is about 330°C.

   T    F    Lattice strains are caused by interstitial impurities, dislocations, and other crystal defects

   T    F    Normal stress is the stress normal to the direction that a uniaxial load is applied. In other words, if the load is applied along the **y-axis** of the bar, the normal stress refers to the stress in the **x-direction.**

   T    F    Metals with face centered cubic crystal structure are generally less strong than metals with body centered cubic crystal structures at least in part because the planes in FCC have high atomic planar density than BCC

   T    F    Poisson's ratio is the ratio of the axial strain to the transverse strain in a uniaxial test ($\nu = \varepsilon_{axial}/\varepsilon_{transverse}$).


2) **{20%} Fill in the blanks with the correct terminology:**

a) The process of increasing the strength and/or hardness of a metal by "squishing" between rollers (plastically deforming) is referred to as:_____.

b) What type of stress causes dislocation slip to occur:_____.

c) A slip system is composed of a_____and a_____.

d) The mechanical property known as_____is defined as the energy required to fracture a specimen.

e) The *equation*, $E=\sigma/\varepsilon$, is known as_____(hint: the equation, not the property)

4) 3) {35 %} As accurately and completely as possible, create a stress-strain diagram based on the following information. LABEL each material property on the diagram, and **show all work** you do to determine various values. If you are unable to determine properties precisely, but can estimate them, describe that as well. **Be sure to put a scale on the stress axis**.

If possible with the data provided determine or estimate: yield strength, tensile strength, ductility, Poisson's ratio and Young's modulus. If not enough information is provided to determine or estimate properties, state so.



Stress (psi)

Strain (in/in)
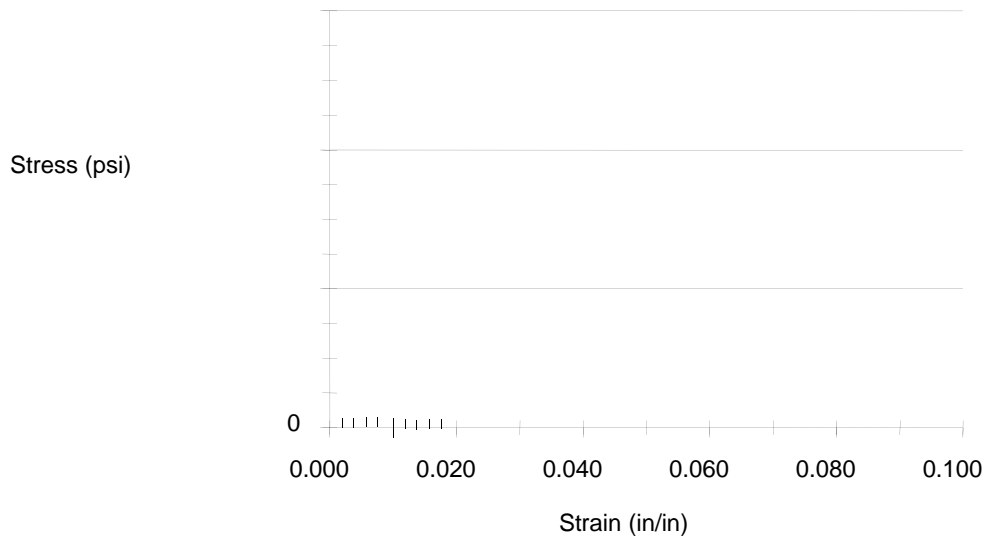
- A uniaxial load is applied to a rectangular bar as shown below. Before loading, the dimensions of the bar are 1 inch wide by 0.5 inch and it is 10 inches long.

- The relationship between force and elongation remains proportional up to 20,000 pounds, then it becomes non-linear. At this point, the strain is 1000 μ-strain ($1000 \times 10^{-6}$ in/in = 0.001in/in = 0.1% strain).

- During the test, the maximum stress experienced was 50,000psi.

- The ductility is 8%EL.



10"

Force
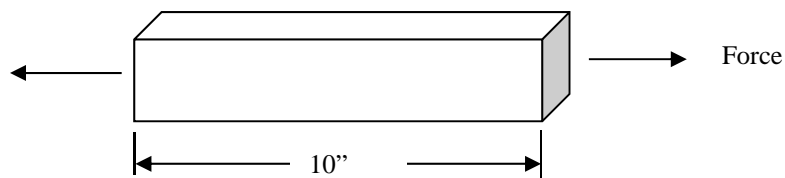
Show all your work:

4) {5 pts} Why must a metal or alloy first be cold worked before recovery, recrystallization and grain growth can occur?

_____

_____

_____

_____

5) {15 pts} Describe what is occurring or changing in the materials for each of the following three related processes.  Include sketches.

Recovery: _____

_____

_____

_____

Recrystallization: _____

_____

_____

_____

Grain growth: _____

_____

_____

_____

6) {5%}  Why must the metal (or alloy) be relatively hot so that recovery, recrystallization and grain growth can occur?  Does increasing temperature have an effect on the rate of these processes, and if so, how so (will higher temperature cause slower, faster or have no effect on the rate that these process occur at)?

_____

_____

_____

_____

7) {5%}  Briefly describe similarities and differences between _hot-rolling_ and _cold-rolling_ (aka _hot-working_ and _cold-working_). Explain the effects of cold rolling on grain structure and the material's strength; if any.

_____

_____

_____

_____