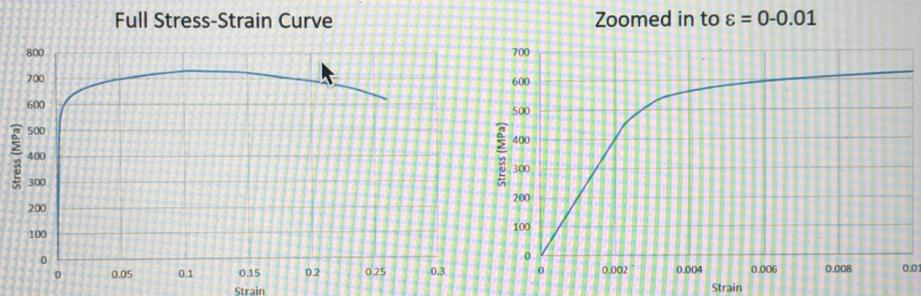## Question 2
<div align="right">1 / 10 pts</div>

Use the stress-strain curve below to answer the questions. On the left is the full stress-strain curve up until fracture. On the right is the same stress-strain curved zoomed into the region where $\varepsilon = 0 - 0.01$

For each of the questions below explain how you would find the values from the stress-strain curve and estimate the value from the curve. Note I realize that estimating the value may be difficult when you can't draw on the graph so as long as you are somewhat close that will be fine. The majority of the points will be awarded for your explanation of how to find the value.

A. (2 points) Find the Elastic Modulus
B. (2 points) Find the yield strength σ_Y
C. (2 points) Find the ultimate tensile strength.
D. (2 points) Find the ductility of the material
E. (2 points) Why is the stress at fracture less than the ultimate tensile stress?
   Explain whether or not this makes physical sense.

Your Answer:

Question 3   4.5 / 10 pts

A. (2 points) Explain what a defect in a material is

B. (2 points) Give an example of when a defect is beneficial to the properties of the material. You must explain how the defect is beneficial to the properties or application of the material to receive credit for this question.

Give one example of each of the following types of defects in materials. **You must explain why it is a defect to earn credit for the question.** You are welcome to draw images to help you explain your answer.

C. (2 points) Point defect

D. (2 points) Linear defect

E. (2 points) Interfacial defect

Your Answer:

A. A defect in a material is an imperfection or an failure but not getting destroyed totally.

B.

C. Point defect is usually missing atoms or few extra atoms. Crystal structures contain enough atoms to be stable; however, missing atoms or few extra atoms can affect the structure such as vacancy.

D. Line of dislocation, edge dislocation. Line defects can weaken or strengthen solids.

E. Grain boundaries: decrease the electrical and thermal conductivity of the material.

| Unanswered | Question 4 | 0 / 10 pts |

Lead (Pb) forms a substitutional solid solution with Tin (Sn). If a Pb-Sn alloy contains 40 wt% Pb and 60 wt% Sn.

A. (5 points) What are the concentrations of each element in at%?

B. (5 points) State which element is the solute and determine the kg of solute per m^3 of the alloy.

Your Answer:

| Unanswered | Question 5 | 0 / 10 pts |

The first 3 peaks in a the XRD pattern of Au are as follows:

- (111) - 2θ = 38.105°
- (200) - 2θ = 44.342°
- (220) - 2θ = 64.517°

Cu – K_a x-rays with a wavelength of 0.15405 nm were used and all the planes are first order reflections, determine the following using the above data:

1. (2 points) The crystal structure of the of Au sample. You must explain how the crystal structure was determined to receive credit

2. (4 points) The lattice parameter of Au. You must show your work to receive credit.

3. (4 points) The atomic radius of Au. You must show your work to receive credit.

Your Answer:

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Your Answer:

Unanswered   **Question 6**   **0 / 10 pts**

(10 points) A zinc ingot is placed adjacent to a copper rod and both are heated to a temperature of 700°C. The diffusion is allowed to proceed for 10 hours. The copper rod initially has a zinc concentration of 35 wt%. The zinc ingot creates a zinc concentration at the surface of the copper rod of 65 wt%. If we assume that the copper rod is semi-infinite, at what distance from the surface of the rod will the concentration of zinc be 42.737 wt%?

Your Answer:

Question 7   **8 / 10 pts**

A. (3 points) What does the linear density of a direction represent and how is it found?

B. (2 points) What is the closed-packed direction of a crystal structure and how can it determined?

C. (5 points) Find the linear density of the [100] direction of a BCC crystal shown below in terms of the atomic radius R. If you need to you may use the VSME to better visualize the crystal. You must show all your work including a drawing to help illustrate where the values came from

C. Uploaded

Question 8   6.5 / 10 pts

A. (3 points) Explain the process of how to draw a plane given its Miller indices (hkl).
   Make sure to clearly describe each step of the process.

B. (3 points) Draw the $\left(2\bar{1}2 \right)$ plane in a cubic system. You must show all your
   work to receive credit.

C. (2 points) Explain what a family of is planes is and how it can be determined if
   planes belong to the same family

D. (2 points) List 2 planes that would be in the same family as the plane from part B.

Your Answer:

A.

+ Translate plane so origin is not on plane

+ Determine distance to intercept plane by travelling along each axis from origin

+ Reciprocal
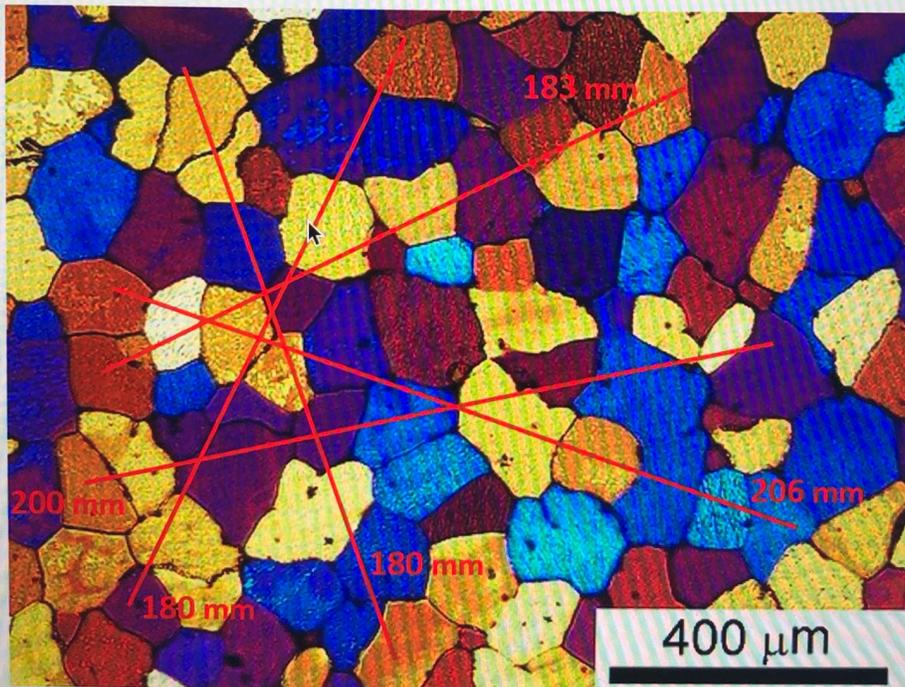
+ Enclose in parentheses (hkl)

B. Uploaded

C. A family of planes contain all planes that are crystallographically equivalent. All the
planes that are crystallographically equivalent can be considered to be belonged to
the same family. Ex: (1 -2 3) and (3 -1 2) belong to {1 2 3} family.

D. (-2 1 -2) and (2 1 -2)

Question 10   6 / 10 pts

Below is a micrograph of the grain structure of a metal with 5 intercept lines drawn on it. The length of each intercept line as measured by a ruler is indicated.

If the length of the scale bar line would measure 80 mm on a sheet paper using a ruler, answer the following questions:

A. (2 points) Explain the process of determining the magnification of the image
B. (4 points) Explain the process of finding the mean intercept length measure of the grain size
C. (4 points) Explain the process of finding the ASTM grain size number