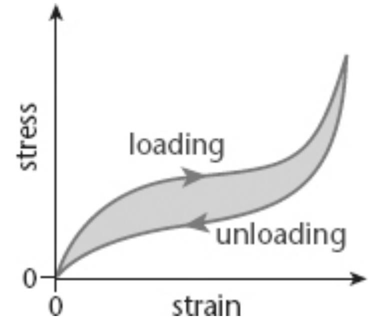
EXAM ONE.



INTRODUCTION

Instructions: I'll assess the Exam 1 questions and count the scores toward your quantitative and qualitative analysis competency grade. You may work on this as much as you like, and start whenever you like. You're allowed to chat about the force and stress analyses with your teammates, if that's helpful to your understanding, but you should write up your exam document on your own. Submit this to me via email (stolk@olin.edu) no later than **class time on Wednesday, September 17.**

MECHANICAL PROPERTIES OF YOUR OBJECT

For this question, you will estimate the mechanical response of one of the material components of your modern artifact (pitchfork, shoe, wheel, canteen, skateboard, hunting vest, or whatever). Choose a component of your object that is made from a single material and that is subjected to relatively simple loading during service, if possible. For example, if you're dealing with a skateboard, you may want to consider the flexural loading of the board. Since you may not yet know exactly what materials are used in your artifact, you will need to guess a material and research properties for your guess. Please cite your sources for everything.

a. Identify your modern object and specify the particular part of the object that you will explore for this question. Inclue a photo or sketch of your object.

b. What specific material do you think is used in your component (your best guess)? How would you classify this material – metal/alloy, ceramic/inorganic glass, polymer, composite, or metalloid?

c. What are some of the mechanical properties of your component? Please do a bit of research and list values for hardness (with scale), Young's modulus, yield strength, tensile strength, and percent elongation.

Property	Units/Scale	Value
Hardness		
Young's Modulus	GPa	
Yield Strength (if your material has one)	MPa	
Tensile Strength, Flexural Strength, or Compressive Strength (whatever is appropriate)	MPa	
Percent elongation	%	

Having trouble finding properties for your material? Random web sites are not always the best place to go for reliable property data. Check out the CES EduPack software installed on some of the materials science lab computers (e.g., the FTIR computer). Take a look at the appendices of the Callister textbook, check out matweb.com, or delve into the ASM Handbooks or ASM Engineered Materials Handbooks. The Callister textbook is a good place to start, as there are some great property tables there. We have copies of the Callister appendices on top of the bookshelf in the materials science lab (AC413).

d. Given the properties you specified in part (c) and what you know about the stress-strain behavior of materials like the one you selected, sketch a schematic engineering stress-engineering strain curve for a tensile test of your component. Be sure to label your axes.

Okay, now we're going to try estimating forces and stresses in your component for a particular loading configuration. Consider how your component may be loaded during service, or during assembly of the project. Is it tension, compression, flexure/bending, shear, or some other type of loading? If your component is subjected to a more complex or combined loading (e.g., tension plus flexure), try to simplify the situation by choosing the type of loading that results in most severe stresses.

e. Select a loading orientation for your component. Your loading orientation may represent the manner in which the part is loaded while it is being used (e.g., a rope in tension, a skateboard in flexure), or you may assume a simplified loading state to enable easier calculations. Sketch your component with the direction of the applied load indicated on the drawing. Is this a tensile, compressive, or flexural load?

f. Estimate the maximum load on your object during service or assembly of your artifact.

g. What cross-sectional area of your component is bearing the maximum applied load?

h. Based on your load and load-bearing area, calculate the maximum stress on your component. **For flexural loading, be sure to use the flexural stress equation**, not the axial stress equation (look it up in your book, or use my lecture notes on the web site).

i. Given the stress you calculated in part (h), describe the type of deformation that occurs in the component. Is it linear elastic, nonlinear elastic, plastic, viscoelastic?