Group Member Names \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Mechanical Properties**

**Pre-Activity:**

1. What is the difference between a material’s strength and a material’s stiffness?

**Activity I: Elastic Deformation**

1. A tensile stress is applied to a metal bar such that is deforms **elastically**. Given is a simplified view of the atoms in the bar before deformation. Sketch what the atoms will look like for conditions b) and c).

Before deformation

b) During deformation while under stress

c) After the stress is released

1. While the bar is under stress, is its volume different than before being deformed? Explain.
2. Does the density increase, decrease, or remain the same during elastic deformation? Explain.

**Activity II: Yield Strength & Plastic Deformation.**

1. How is the strength of a metal defined? (Please give description that a 2nd year engineering student who has not taken this class yet would understand.)
2. What is the difference between yield strength and tensile strength?
3. A tensile stress is applied to a metal bar such that it deforms **plastically**. Given is a simplified view of the atoms in the bar before deformation. Sketch what the atoms will look like for conditions b) and c).

Before deformation

b) During deformation while under stress

1. After the stress is released
2. After the stress is released, is the bar’s volume different than before being deformed? Explain.
3. Does the density increase, decrease, or remain the same after plastic deformation? Explain.

**Activity III: Student Dialog Questions**

Below are comments from students. For each comment, indicate whether you think that each student is correct, incorrect, or some of both. Then give a quick explanation for your choice by indicating the strengths and/or weaknesses of the student’s statement.

1. Student A says: “Steel has a yield strength of 180 MPa and Nickel only has a yield strength of 130 MPa. Steel is therefore stronger and more force is needed to break it.”

Correct, Partially Correct, Incorrect

Explanation:

1. Student B says: “A metal with a greater yield strength will deform less before it breaks and therefore is less ductile and more brittle than a weaker metal.”

Correct, Partially Correct, Incorrect

Explanation:

**Activity IV: Stress-Strain Plots**

Information about strength and Young’s modulus can be obtained from a stress vs. strain curve. A stress-strain curve for a metal is drawn below.

1. Indicate the features which would characterize the Young’s modulus, yield strength, tensile strength, ductility, and toughness.

Strain. (Δ length/length)

Stress:

(Force applied/Area)

13. Rank the two curves:

A

B

Modulus, E: **A** ( > , < , = ) **B**

Stress 

Yield strength: **A** ( > , < , = ) **B**

Tensile strength: **A** ( > , < , = ) **B**

Ductility: **A** ( > , < , = ) **B**

Strain 

**Activity V: Challenge Question**

14. The following metal pieces are cut from the same plate. Compare the yield strength of the pieces. Explain.

A

(A and B have equal heights)

B

a) A has a higher yield strength than B.

b) B has a higher yield strength than A.

c) A and B have the same yield strength.

**Activity VI: Looking Backward**

15. When you put a metal under tension, different changes occur in the metal in the elastic and plastic regions as

seen by the stress vs. strain curve and the atomic pictures you drew. Please **discuss** the differences between a material’s strength and a material’s stiffness on both a microscopic and macroscopic scale. Then summarize your ideas here. (We are not looking for definitions, and your response should be more sophisticated than in #1.)