| **Problem Set Submission** | **Due – October 7th 2022** |
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| Please submit a scanned copy or typed document of your assignment to Quercus. Please make sure that your name and student number at the top of every page. Show all work and sample calculations where appropriate. Please clearly indicate all answers as neatly as possible. **If possible, please condense all work into a single .pdf file.**<br>A late submission will result in a 20% grade penalty per day | |

1. Compare and contrast elastic and plastic deformation in terms of – macroscopic sample deformation, atomic positions, and location on a stress-strain curve **[4]**

2. A) A dog-bone coupon of nickel is loaded along its long axis for a uniaxial tensile test. The sample has a total length of 60 cm, a reduced section length of 15 cm, a thickness of 5 mm and is loaded with 5 kN. The sample width in the gripped region is 1.5 cm, with a reduced region that is a third of this width. What is the elongation in the rod when this load is applied if the Young's modulus of this material is 205 GPa.**[3]**

B) If we wanted to now design a cylindrical coupon which experiences the same elongation at the same force for the same material, what radius would this cylindrical coupon need to have? **[2]**

3. Determine which material below fits the following descriptions best – **[6]**
    a. The maximum length that can be reached by applying tension on a 50cm metal bar before it begins to plastically deform is 50.04 cm
    b. The material with the lowest strain at yield strength
    c. The material with the highest strain at yield strength
    d. The required applied force to plastically deform a tensile specimen with a rectangular cross-sectional area (10mm x 5mm) is 22.5 kN

| **Material** | **Yield Strength (MPa)** | **Modulus of Elasticity (GPa)** |
|---|---|---|
| Tungsten | **550** | **407** |
| Steel | **180** | **207** |
| Nickel | **138** | **190** |
| Titanium | **450** | **107** |
| Brass | **77** | **97** |
| Aluminum | **35** | **69** |
| Magnesium | **130** | **45** |

4. Imagine you are an engineer part of a rescue team, and your team has decided to help a secret research lab in danger after a volcanic eruption in Hawaii. The only path out of the village was a bridge over a tumultuous river that is now destroyed. Although the scientists escaped safely with helicopters, a herd of resurrected Dodos remains trapped.

   You have a plan to quickly replace the bridge as the stone bases on both sides of the river are still in place, with a span of 12 meters. The Dodos and their nestlings respectively weigh 20kg and 4kg and were cloned from residual blood in a Victorian-era mosquito smashed in Charles Darwin's notebook. **[3]**

   a) The bridge will be made of tempered glass with a facture strength of 110 MPa that comes at a width of 1 meter and enough length to build the bridge. The manufacturer now awaits your decision on the thickness of the glasses. If the maximum number of Dodos and their babies simultaneously on the bridge is respectively 40 and 12, what is the minimum thickness in millimeters required for the safe crossing of the Dodos? (Hint, you can assume all weights only exert force to the center of the bridge, don't overthink this problem!) **[2]**

   b) b) If the Young's modulus of this glass is 75 GPa, Sketch the stress strain curve that you would expect for this sample. Label all important points. **[1]**