APS110 Problem Set #2 **Due – October 28th**

Please submit all answers to the questions (this can be on the file itself, written electronically or by hand, or photocopies/scans of your work) in as neat of a fashion as possible, and a single file if possible.

A late penalty of 20% per day will be applied to late submissions.

1. Potassium iodine is a compound that can be used in medications. Given that the compound exhibits the rock salt crystal structure and the atomic radii of potassium (r = 0.138 nm) and iodine (r = 0.220 nm), answer the following - **(8)**
    a. Draw a sketch of the crystal structure. Clearly indicate the positions of the potassium and iodine atoms. Show a calculation for the total number of each atom in the lattice **(3)**

    b. Derive a relationship for the unit cell length (a) in terms of the radii of the anions and cations. **(2)**

    c. Calculate the theoretical density of potassium iodine. The atomic weights of potassium and iodine can be assumed to be 39.09 (potassium) and 126.90 (iodine) **(3)**

2. Based on the load and length data provided below, draw a stress vs. strain curve. Assume that the sample is loaded in tension uniaxially with an original length of 50.8 mm and a diameter of 12.8 mm and has a Young's Modulus of 60 GPa. Assume that the sample fractures after the last data point collected. **[10]**

Load (kN)	**Length (mm)**
0	50.8
7.3	50.851
15.1	50.902
23.1	50.952
30.4	51.003
34.4	51.054
38.4	51.308
41.3	51.816
44.8	52.832
46.2	53.848
47.3	54.864
47.5	55.88
46.1	56.896
44.8	57.658
42.6	58.42
36.4	59.182

a. Construct a stress-strain curve from the provided information. Make sure to label all important aspects of the curve **(2)**

b. Estimate the values for the yield strength, ultimate tensile strength, and fracture strength. **(3)**

c. At a stress value of 300 MPa, calculate the plastic and elastic strain assuming that the sample remains loaded. **(5)**

3. Consider two samples of an unknown metal. The first piece of metal is heated from 600˚C to 820˚C, while the second is heated from 500˚C to 700˚C. The first sample shows 123 times more vacancies upon being heated, while the second shows 225 times more vacancies after its heating cycle. Which sample has the highest vacancy defect formation energy? **(5)**

4. Briefly discuss the role of the following defects in strengthening materials. In your answers, make specific mentions of the mechanism of dislocation movements, and how differences in the way these defects are introduced (number or size) can influence strength. Please keep all answers to **4-5 sentences** at most.
    a. Grain boundaries **(3)**

    b. Cold working **(2)**

5. Draw a standard tensile curve for a polymer sample. Make note of the two important strength values on this curve and define what each of these values refers to. **(4)**