

## **Materials**

### **Things you should learn:**

1. The dimensions of an atom (If the orbit of the electron around an H nucleus were the perimeter of a football stadium, how big would its nucleus be?)
2. Why electrons orbiting nuclei don't fly off into space (why don't nuclei explode)
3. The different ways that atoms bond together to form molecules/substances
4. Types of solids
5. Why water is a very strange molecule
6. Why many materials are crystalline; others are not
7. What's unusual about the behavior of valence electrons in metals
8. The concept of an equilibrium distance between atoms in a substance
9. The nature of the forces if those distances are reduced or increased
10. How a book on a table is supported by the table
11. What is Hooke's Law and how does it relate to a grocery scale
12. How Young's modulus characterizes a material
13. Determining material properties through tensile testing
14. Events in the life of a specimen which eventually fails in tension
15. Characterizing properties of materials (toughness, hardness, ductility, . . .)
16. How stresses are distributed in a material undergoing bending
17. Parameters that affect the strength of a material in tension
18. How materials can fail in compression
19. The role of "moment of inertia" in Euler buckling
20. Why I-beams, box girders, hollow tubes

### **Things you should be able to do**

1. Describe the properties of a material from a stress-strain curve
2. "Design" a material with specific properties by sketching its stress-strain curve
3. Design structural members that maximize "moment of inertia" while minimizing total material
4. Predict the Euler buckling load of a beam (in comparison to another with similar geometry)

### **Things you should like awake thinking about:**

1. Why might a stress-strain curve be dependent on the rate at which it is deformed (elongated)
2. What other materials are there that are not "Hookean solids"; what's different about them?
3. What length of material could you suspend before it would break under its own weight? Aluminum? Piano wire? Concrete? Spider silk?