DAY 23

Homework Assignment (see syllabus for homework collection information)

1. A rubber band shows elastic behavior until it reaches a certain level of deformation. After that, further stress on the band does not result in significant additional deformation. When the stress in the band is high enough, the band breaks. Make a strain vs. stress plot for this.

2. A fountain consists of water jets mounted so that their nozzles are 2 ft above a pool. Each jet squirts water out at a 45° angle. The water lands in the pool approximately 4 feet from the jet. The nozzle on the jet is 0.5 inch in diameter. There are eight of these jets in the fountain. At what rate must water be pumped through the fountain (in gallons/hour)?

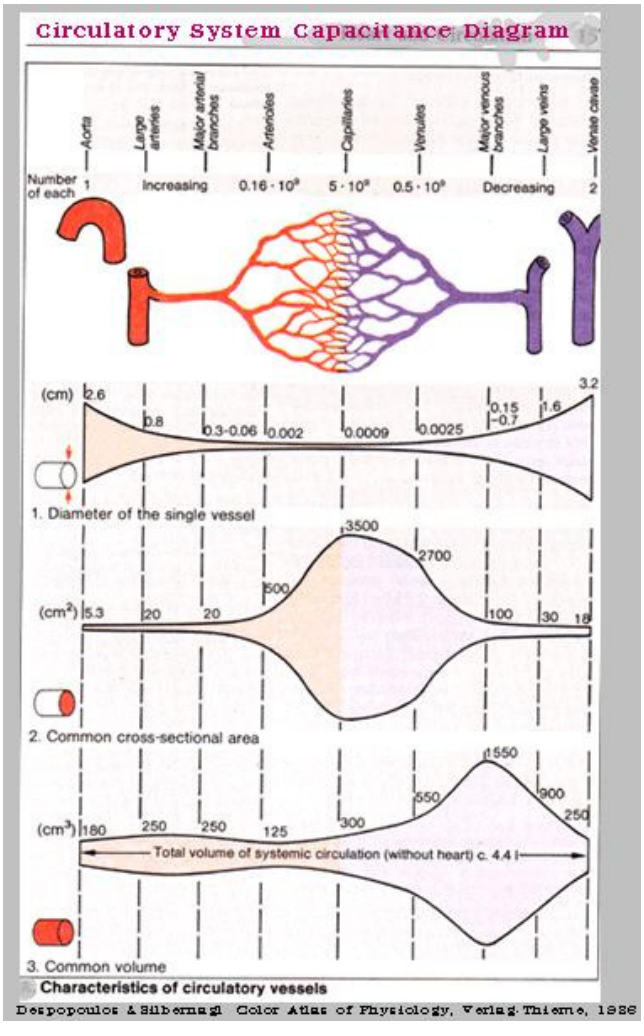
http://www.phototour.minneapolis.mn.us/142

3. In an air compressor, air is pumped into a storage tank and compressed by a factor of 10 (meaning its density will increase by a factor of ten). The intake orifice on the compressor measures 2 cm in diameter. If the compressor will fill a 10 liter tank in 3 minutes, what is the speed at which air flows into the intake orifice?

4. Four rods are all 1 meter long and 2 cm in diameter. One is made of glass, one is made of steel, one is made of wood, and one is made of soft plastic. Each rod is placed in a vise and its end moved in the clockwise direction until the rod breaks. Discuss what will happen for each rod. Make a stress/strain plot (estimate) for each, and put all four plots on the same set of axes.

5. Refer to the diagram. Use the information given to answer this question. Blood (density = 1.0 g/cm^3) flows through an aorta at a speed of 40 cm/s. Determine the cross-sectional area of the aorta and calculate the mass flow rate (in grams per second). Determine the number of arterioles and the average area of each arteriole. Calculate the average flow speed of blood in the arterioles.

6. Water moves through a 4 inch diameter pipe under a pressure of 20 psi at a



rate of 1 gallon/second. The pipe is then reduced in size to 2 inches in diameter. What is the speed of the water in both sections of the pipe?

7. In the above problem, what is the water pressure in the smaller pipe?

8. Sketch the stress/strain curve for the bones of an 80-year-old and a 14-year-old.

9. How much will a 10 meter long, 1 mm-diameter copper wire stretch when a 0.5 kg mass is hung from it? How much mass can be hung before the wire yields? Breaks?

   HINT – You'll need the elastic properties tables. Use the lower limits if a range of values is given.

10. A nozzle squirts out a stream of liquid of diameter d_{nozzle}. The nozzle is angled at θ above the horizontal. Show that the diameter the stream when it is at its maximum height (d_{stream}) is given by the equation at right (in other words, derive the equation), and therefore does not depend on the rate at which the liquid is coming out of the nozzle, the type of liquid, or anything else.

$$d_{stream} = \frac{d_{nozzle}}{\sqrt{\cos(\theta)}}$$

11. Try the equation from the above problem on the example problem #3 for today and see if it gives the same result.

12. A very long copper wire hangs from the top of a crane. What part of the wire is under the most stress? Which is under the least? What about strain? Where is it greatest and least?

13. The cable mentioned in the previous problem has length L, cross-sectional area A, and mass m. Show that the stress in the cable a distance y from the bottom is

$$Stress = \frac{mgy}{LA}$$

and discuss whether this agrees with your answer to the above problem.

14. **PHY 231 ONLY**

In 2010 scientists develop a new type of material that is designed to get stiffer the more stress it is under. This material is called Nu-Steel. Essentially Young's modulus is variable for Nu-Steel, whereas it is constant in material like regular steel. Derive an equation for the Young's Modulus of Nu-Steel from the test data at right and calculate at what stress level Nu-Steel will be 50% stiffer than regular steel.

Strain	Nu-Steel Stress (Pa)	Regular Steel Stress (Pa)
0.000000	0.000E+00	0.000E+00
0.000495	1.040E+08	1.040E+08
0.000980	2.061E+08	2.059E+08
0.001456	3.069E+08	3.058E+08
0.001923	4.071E+08	4.038E+08
0.002381	5.078E+08	5.000E+08
0.002830	6.104E+08	5.943E+08
0.003271	7.164E+08	6.869E+08
0.003704	8.276E+08	7.778E+08
0.004128	9.460E+08	8.670E+08
0.004545	1.074E+09	9.545E+08
0.004955	1.214E+09	1.041E+09