Physics 1114: Unit 6 Homework

Problem set 1

1. A rod 4.2 m long and 0.50 cm^2 in cross-sectional area is stretched 0.20 cm under a tension of 12,000 N. (a) What is the applied stress? (b) What is the resulting strain? (c) What is Young's modulus for this material?

2. A typical value for systolic blood pressure is 120 mm Hg. Convert this to (a) N/m^2, (b) atm, (c) lb/in^2.

3. The arm of a record player exerts a force of 0.0098 N (the weight of 1 gram) on a record. If the diameter of the stylus is 0.0013 cm find the pressure on the record groove in N/m^2 and in atmospheres. (Assume a circular cross-section.)

4. (a) Calculate the downward force (in N) of the atmosphere acting on the top of a table that measures 3.2 m by 1.2 m. (b) What is the total force acting upward on the underside of the table?

5. (a) On a day when the atmospheric pressure is 14.8 psi a tire is inflated to 32.1 psi. What is the absolute pressure inside the tire? (b) What will the pressure gauge read on the following day when the atmospheric pressure has fallen to 14.6 psi?

6. The contraction of the left ventricle (chamber) of the heart pumps blood into the body. Assuming that the inner surface of the left ventricle has an area of 85 cm^2 and the maximum pressure in the blood is 120 mm Hg, calculate the total force exerted by the ventricle at the point of maximum pressure.

7. What is the difference in blood pressure between the top of the head and bottom of the feet of a 1.60 m tall person standing vertically? Blood density = 1030 kg/m^3.

8. Determine the minimum fluid pressure needed in the water pipe leading into the basement of a building if water is to come out of a faucet on the twelfth story 40 m above.

Problem set 2

1. Intravenous infusions are often made by connecting the needle (inserted in the arm) by a tube to a raised bottle full of fluid. Assuming the fluid has a density of 1000 kg/m^3, (a) at what height h should the bottle be placed above the needle so that the liquid pressure is 60 mm Hg? (b) If the blood pressure is 18 mm Hg above atmospheric pressure, how high should the bottle be placed so that the fluid just barely enters the vein? (Let h refer to the vertical height of the fluid surface in the bottle above the needle.)

2. The maximum fluid pressure in a hydraulic lift is 16 atm. What is the heaviest vehicle (kg) it can lift if the diameter of the output line is 17 cm? (Assume a circular cross-section.)

3. A 3.0 N force is applied to the plunger of a hypodermic needle. If the diameter of the plunger is 1.0 cm and that of the needle 0.20 mm, (a) with what force does the fluid leave the needle? (b) What force on the plunger would be needed to push fluid into a vein where the pressure is 18 mm Hg?

4. How much force is required to raise a 1000 kg block of concrete to the surface of a freshwater lake? How much force is needed to lift it out of the water? The density of concrete is 2.3×10^3 kg/m^3.

5. A freight ship has a horizontal cross-sectional area of 3100 m^2 at the water line. When loaded, the ship drops 6.1 m. What is the mass of its load? The density of sea water is 1025 kg/m^3.

6. A raft 2.6 m wide, 4.0 m long, and 0.72 m high is made from solid balsa wood (density = 130 kg/m^3). How much weight can it support in seawater ($\rho = 1025\,\mathrm{kg/m^3}$)?

7. A uniform cube of wood is 0.25 m on each edge. It is floating in pure water with its upper surface 0.07 m above the surface of the water. Determine the density of the wood.

Problem set 3

1. Convert these temperatures. a) The surface temperature of the sun: 5160 K to °C and °F. b) The "night-time" surface temperature of the moon: -173°C to °F and K. c) Normal body temperature: 98.6°F to °C and K.

2. An aluminum wire 1.4 km long is strung between two towers for the transmission of electricity.

   a) How much does its length change when the temperature goes from -10°C to 40°C? ($\alpha = 22.2 \times 10^{-6}$ °C^{-1}).

   b) If the wire is 1.4 km long when the temperature is -10°C, how long will it be when the temperature reaches 20°C?

3. An automobile tire is filled to a gauge pressure of 2×10^5 N/m^2 at 10°C. After driving 100 km, the temperature within the tire rises to 40°C. What is the pressure within the tire now? Atmospheric pressure is 1.01×10^5 N/m^2. Remember to use *absolute* pressure and temperature in the calculation. State your final answer as gauge pressure.

4. STP means Standard Temperature and Pressure (0°C and 1 atm). If 5.00 m^3 of gas initially at STP is placed under a pressure of 4.0 atm and the temperature of the gas rises to 25°C, then what is the final volume?

5. If 50.0 L of oxygen at 10°C and an absolute pressure of 1.88 atm are compressed to 36.6 L and at the same time the temperature is raised to 80°C, what will the new pressure be?

6. A sample of gas occupies 2.0×10^{-3} m^3 at an absolute pressure of 1.0 atm and a temperature of 0°C. Find its volume at the same pressure and a temperature of 200°C. Find its pressure at a volume of 5.0×10^{-4} m^3 and a temperature of 200°C.

7. Describe what happens when the temperature of a gas is decreased while the pressure remains constant. Explain this change based on the Kinetic-Molecular Theory.