PHYS-2010: Dr. Luttermoser's General Physics I Course
Problem Set 3, Fall 2023

There are two sections to this Problem Set, the first section of problems are located on the textbook publisher's *WebAssign* web site:

https://webassign.com

These problems will be graded and must be completed by 6:00 p.m. on Friday, November 10, 2023. **Start working on these problems immediately once they are posted on *WebAssign*. Don't wait until the last day to start them. One never knows when the network will go down, and you will not be able to use this as an excuse for not doing your *WebAssign* problems.** As a matter of fact, there will be no allowed excuses for not doing your *WebAssign* homework.

Once you click on the *WebAssign* web site above, click on the "Enter Class Key" button on the upper right of this web page. The class key for this course is:

etsu 9680 9716

A Quick Start Guide for using this web site can be found on the course web page. Should you need additional assistance with *WebAssign*, you can contact Technical Support information at:

https://webassign.com/support/student-support/

via the web or

1-800-354-9706

by telephone.

The following problems will not be graded, but should be done for review. The solutions are posted on the course web page. **Try to work these problems out by yourself before looking at the solutions I have supplied for you.**

1. One end of a uniform 4.0–m–long rod of weight w is supported by a cable at an angle of $\theta = 37°$ with the rod. The other end rests against a wall, where it is held by friction. The coefficient of static friction between the wall and the rod is $\mu_s = 0.50$. Determine the minimum distance x from point A at which an additional weight w (the same as the weight of the rod) can be hung without causing the rod to slip at point A.

2. Four objects are held in position at the corners of a rectangle by light rods. The 4 objects have the following masses an locations: $m_1 = 2.00$ kg, $x_1 = 2.00$ m, $y_1 = 3.00$ m; $m_2 = 3.00$ kg, $x_2 = -2.00$ m, $y_2 = 3.00$ m; $m_3 = 2.00$ kg, $x_3 = -2.00$ m, $y_3 = -3.00$ m; $m_4 = 4.00$ kg, $x_4 = 2.00$ m, $y_4 = -3.00$ m. Find the moment of inertia of the system about (a) the x-axis, (b) the y-axis, and (c) an axis through the origin and perpendicular to the page. (d) If this system is set into rotation about each of these axes, find the torque that will produce an angular acceleration of 1.50 rad/s in each case.

3. Halley's comet moves about the Sun in an elliptical orbit, with its closest approach to the Sun being 0.59 A.U. and its greatest distance being 35 A.U. (1 A.U. is the Earth–Sun distance). If the comet's speed at closest approach is 54 km/s, what is its speed when it is farthest from the Sun? You may neglect any changes in the comet's mass and assume that its angular momentum about the Sun is conserved.

4. If 1.0 m^3 of concrete weighs 5.0×10^4 N, what is the height of the tallest cylindrical concrete pillar that will not collapse under its own weight? The compression strength of concrete (the maximum pressure that can be exerted on the base of the structure) is 1.7×10^7 Pa.

5. A collapsible plastic bag contains a glucose solution which is connected through a tube into a person's vein. If the average gauge pressure in the in the vein is 1.33×10^3 Pa, what must be the minimum height h of the bag in order to infuse glucose into the vein? Assume the specific gravity of the solution is 1.02.

6. A sample of an unknown material appears to weigh 300 N in air and 200 N when immersed in alcohol of specific gravity 0.700. What are (a) the volume and (b) the density of the material?

7. (a) Calculate the mass flow rate (in grams per second) of blood ($\rho = 1.0$ g/cm^3) in an aorta with cross–sectional area of 2.0 cm^2 if the flow speed is 40 cm/s. (b) Assume that the aorta branches to form a large number of capillaries with a combined cross-sectional area of 3.0×10^3 cm^2. What is the flow speed in the capillaries?

8. The pulmonary artery, which connects the heart to the lungs, has an inner radius of 2.6 mm and is 8.4 cm long. If the pressure drop between the heart and lungs is 400 Pa, what is the average speed of blood in the pulmonary artery?

9. The aorta in humans has a diameter of about 2.0 cm, and at certain times the blood speed through it is about 55 cm/s. Is the blood flow turbulent? The density of whole blood is 1,050 kg/m^3, and its coefficient of viscosity is 2.7×10^{-3} N $\cdot$ s/m^2.

10. A pair of eyeglass frames are made of epoxy plastic with a coefficient of linear expansion of 1.30×10^{-4} °C^{-1}. At room temperature (20.0°C), the frames have circular lens holes 2.20 cm in radius. To what temperature must the frames be heated if lenses 2.21 cm in radius are to be inserted into them?

11. Lead pellets, each of mass 1.00 g, are heated to 200°C. How many pellets must be added to 500 g of water that is initially at 20.0 °C to make the equilibrium temperature 25.0°C? Neglect any energy transfer to or from the container.

12. A beaker of water sits in the sun until it reaches an equilibrium temperature of 30.0°C. The beaker is made of 100 g of aluminum and contains 180 g of water. In an attempt to cool this system, 100 g of ice at 0°C is added to the water. (a) If $T_f = 0°\text{C}$, determine how much ice remains. (b) Assume you start with 50 g of ice with the same initial setup. What will be the final equilibrium temperature of the system?

13. A window has a glass surface area of 1.6×10^3 cm^2 and a thickness of 3.0 mm. (a) Find the rate of energy transfer by conduction through the window when the temperature of the inside surface of the glass is 70°F and the outside temperature is 90°F. (b) Repeat for the same inside temperature and an outside temperature of 0°F.

14. Measurements on two stars indicate that Star X has a surface temperature of 5,727°C and Star Y has a surface temperature of 11,727°C. If both stars have the same radius, what is the ratio of the luminosity (i.e., total power output) of Star Y to the luminosity of Star X? Both stars can be considered to have an emissivity of 1.0, hence can be considered to be blackbodies.

15. A family comes home from a long vacation with laundry to do and showers to take. The water heater has been turned off during the vacation. If the heater has a capacity of 50.0 gallons and a 4,800–W heating element, how much time (in hours) is required to raise the temperature from 20.0°C to 60.0°? Assume the heater is well insulated and no water is withdrawn from the tank during that time.