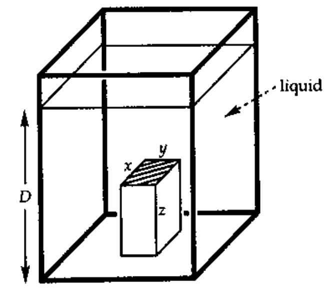
AP Physics 2: Fall Semester Wizard Challenges by Unit

These problems are more advanced than those in the regular homework: successfully completing them will earn you one point per problem, applied to the Assessments category of your grade. Limit of ten points: partial credit is given for legitimate attempts.

Please print this PDF and write on it, for ease of grading.

Unit 1.

1. (Section 1.1) In the figure, a box of dimensions x, y, and z rests on the bottom of a tank filled to depth D with a liquid of density ρ. If the tank is open to the atmosphere, what is the force on the (shaded) top of the box?

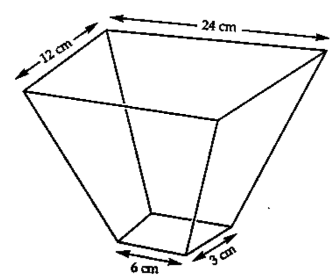


2. (Section 1.4) The blood flow speed through an aorta with a radius of 1.00 cm is 0.265 m/s. If hardening of the arties causes the aorta to be constricted to a radius of 0.800 cm, by how much would the velocity increase?

3. (Section 1.5) To drink a soda (assume the same density as water) through a straw requires that you lower the pressure at the top of the straw. What does the pressure need to be at the top of a straw that is 15.0 cm above the surface of the soda in order for the soda to reach your lips?

4. (Section 1.4) Water flowing through a wide horizontal tube is constricted to half the diameter. If the water speed is 1.5 m/s in the larger part of the tube, by how much does the pressure drop in the constricted part? Express the final answer in atmospheres.

5. (Section 1.4) This figure shows a portion of a conduit for water, one with rectangular cross sections. If the flow speed at the top is v, what is the flow speed at the bottom?



6. (Section 1.5) A pump is used to send water through a hose, the diameter of which is 10 times that of the nozzle through which the water exits. If the nozzle is 1 m higher than the pump, and the water flows through the hose at 0.4 m/s, what is the gauge pressure of the water at the pump?

Unit 2.B

1. In grinding a steel knife blade (specific heat = 460 J/Kg•°C), the metal can get as hot as 400.°C. If the blade's mass is 80.0 g, what is the minimum amount of 20°C water needed for quenching the hot blade if the water is not to rise above boiling?

Unit 2.C

1. An engineer wants to run a heat engine with a Carnot efficiency of 40.0 % between a high-temperature reservoir at 300.0 °C and a low-temperature reservoir. What is the maximum Celsius temperature of the low-temperature reservoir?

2. A Carnot engine takes in heat from a reservoir at 350 °C and has an efficiency of 35%. The exhaust temperature is not changed and the efficiency is increased to 40%. What is the new Celsius temperature of the hot reservoir?

3. A 1.0 kg amount of 100.0 °C water is placed around a cylinder of a cool, ideal gas, connected to a piston. As the water cools down to 55.0 °C, the gas in the cylinder heats up, pushing a piston so it lifts a 1.2 kg mass up (vertically) 0.25 m. How much work did the piston do? What's the thermal efficiency of this system?

4. A heat engine operating between 40°C and 380°C has an efficiency 60% of that of a Carnot engine operating between the same temperatures. If the engine absorbs heat at a rate of 60 kW, at what rate does it exhaust heat?

Unit 3.A

1. (Section 3.A.1) How many electrons would have to be placed on a 4.6 E -12 kg object to make it hover in an electric field of 4.5 E -3 N/C directed downward between two parallel plates?

2. (Section 3.A.2) Two charges, -3.0 C and -4.0 C, are located at (-0.5 m, 0 m), and (0.5 m, 0 m), respectively. Find the point on the x-axis between the two charges where the electric field is zero.