# PH 201 Homework Assignment Chapter on Fluids – 32 Problems Total

**1.** One of the concrete pillars that support a house is 2.2 m tall and has a radius of 0.50 m. The density of concrete is about 2.2 x $10^3$ kg/m$^3$. Find the weight of this pillar in pounds (1 N = 0.2248 lb).

### Solution for Problem 1

**2.** Accomplished silver workers in India can pound silver into incredibly thin sheets, as thin as 3.00 x $10^{-7}$ m (about one-hundredth of the thickness of this sheet of paper). Find the area of such a sheet that can be formed from 1.00 kg of silver.

### Solution for Problem 2

**3.** Neutron stars consist only of neutrons and have unbelievably high densities. A typical mass and radius for a neutron star might be 2.7 x $10^{28}$ kg and 1.2 x $10^3$ m. **(a)** Find the density of such a star. **(b)** If a dime ($V$ = 2.0 x $10^{-7}$ m$^3$) were made from this material, how much would it weigh (in pounds)?

### Solution for Problem 3

**4.** A full can of black cherry soda has a mass of 0.416 kg. It contains 3.54 x $10^{-4}$ m$^3$ of liquid. Assuming that the soda has the same density as water, find the volume of aluminum used to make the can.

### Solution for Problem 4

**5.** An airtight box has a removable lid of area 1.3 x $10^{-2}$ m$^2$ and negligible weight. The box is taken up a mountain where the air pressure outside the box is 0.85 x $10^5$ Pa. The inside of the box is completely evacuated. What is the magnitude of the force required to pull the lid off the box?
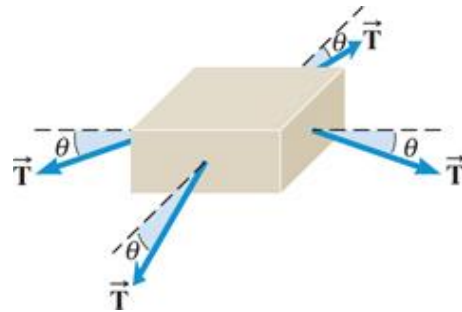
### Solution for Problem 5

**6.** A solid concrete block weighs 169 N and is resting on the ground. Its dimensions are 0.400 m x 0.200 m x 0.100 m. A number of identical blocks are stacked on top of this one. What is the smallest number of whole blocks (including the one on the ground) that can be stacked so that their weight creates a pressure of at least two atmospheres on the ground beneath the first block?

### Solution for Problem 6

**7.** A glass bottle of soda is sealed with a screw cap. The absolute pressure of the carbon dioxide inside the bottle is $1.80 \times 10^5$ Pa. -Assuming that the top and bottom surfaces of the cap each have an area of $4.10 \times 10^{-4}$ m², obtain the magnitude of the force that the screw thread exerts on the cap in order to keep it on the bottle. The air pressure outside the bottle is one atmosphere.

<u>**Solution for Problem 7**</u>

**8.** As the initially empty urinary bladder fills with urine and expands, its internal pressure increases by 3300 Pa, which triggers the micturition reflex (the feeling of the need to urinate). The drawing shows a horizontal, square section of the bladder wall with an edge length of 0.010 m. Because the bladder is stretched, four tension forces of equal magnitude $T$ act on the square section, one at each edge, and each force is directed at an angle $\theta$ below the horizontal. What is the magnitude $T$ of the tension force acting on one edge of the section when the internal bladder pressure is 3300 Pa and each of the four tension forces is directed 5.0° below the horizontal?

<u>**Solution for Problem 8**</u>

**9.** The Mariana trench is located in the floor of the Pacific Ocean at a depth of about 11 000 m below the surface of the water. The density of seawater is 1025 kg/m³. **(a)** If an underwater vehicle were to explore such a depth, what force would the water exert on the vehicle's observation window (radius = 0.10 m)? **(b)** For comparison, determine the weight of a jetliner whose mass is $1.2 \times 10^5$ kg.

<u>**Solution for Problem 9**</u>

**10.** The drawing shows an intravenous feeding. With the distance shown, nutrient solution ($\rho$ = 1030 kg/m³) can just barely enter the blood in the vein. What is the gauge pressure of the venous blood? Express your answer in millimeters of mercury.



Atmospheric pressure

0.610 m

**Solution for Problem 10**

**11.** The human lungs can function satisfactorily up to a limit where the pressure difference between the outside and inside of the lungs is one-twentieth of an atmosphere. If a diver uses a snorkel for breathing, how far below the water can she swim? Assume the diver is in salt water whose density is 1025 kg/m³.

**Solution for Problem 11**

**12.** A mercury barometer reads 747.0 mm on the roof of a building and 760.0 mm on the ground. Assuming a constant value of 1.29 kg/m³ for the density of air, determine the height of the building.
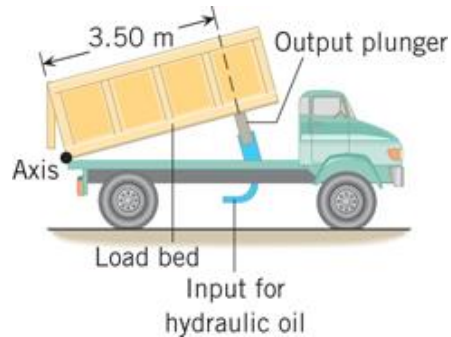
**Solution for Problem 12**

**13.** The atmospheric pressure above a swimming pool changes from 755 to 765 mm of mercury. The bottom of the pool is a rectangle (12 m x 24 m). By how much does the force on the bottom of the pool increase?

**Solution for Problem 13**

**14.** A barber's chair with a person in it weighs 2100 N. The output plunger of a hydraulic system begins to lift the chair when the barber's foot applies a force of 55 N to the input piston. Neglect any height difference between the plunger and the piston. What is the ratio of the radius of the plunger to the radius of the piston?

**Solution for Problem 14**

**15.** A dump truck uses a hydraulic cylinder, as the drawing illustrates. When activated by the operator, a pump injects hydraulic oil into the cylinder at an absolute pressure of 3.54 x 10$^6$ Pa and drives the output plunger, which has a radius of 0.150 m. Assuming that the plunger remains perpendicular to the floor of the load bed, find the torque that the plunger creates about the axis identified in the drawing.



**Solution for Problem 15**

**16.** The density of ice is 917 kg/m$^3$, and the density of seawater is 1025 kg/m$^3$. A swimming polar bear climbs onto a piece of floating ice that has a volume of 5.2 m$^3$. What is the weight of the heaviest bear that the ice can support without sinking completely beneath the water?

**Solution for Problem 16**

**17.** A duck is floating on a lake with 25% of its volume beneath the water. What is the average density of the duck?

**Solution for Problem 17**

**18.** An 81-kg person puts on a life jacket, jumps into the water, and floats. The jacket has a volume of 3.1 x 10$^{-2}$ m$^3$ and is completely submerged under the water. The volume of the person's body that is under water is 6.2 x 10$^{-2}$ m$^3$. What is the density of the life jacket?

**Solution for Problem 18**

**19.** What is the smallest number of whole logs ($\rho$ = 725 kg/m$^3$, radius = 0.0800 m, length = 3.00 m) that can be used to build a raft that will carry four people, each of whom has a mass of 80.0 kg?

**Solution for Problem 19**

**20.** A hot-air balloon is accelerating upward under the influence of two forces, its weight and the buoyant force. For simplicity, consider the weight to be only that of the hot air within the balloon, thus ignoring the balloon fabric and the basket. The hot air inside the balloon has a density of $\rho_{hot\ air}$ = 0.93 kg/m³, and the density of the cool air outside is $\rho_{cool\ air}$ = 1.29 kg/m³. What is the acceleration of the rising balloon?

### Solution for Problem 20

**21.** To verify her suspicion that a rock specimen is hollow, a geologist weighs the specimen in air and in water. She finds that the specimen weighs twice as much in air as it does in water. The density of the solid part of the specimen is 5.0 x 10³ kg/m³. What fraction of the specimen's apparent volume is solid?

### Solution for Problem 21

**22.** A fuel pump sends gasoline from a car's fuel tank to the engine at a rate of 5.88 x 10⁻² kg/s. The density of the gasoline is 735 kg/m³, and the radius of the fuel line is 3.18 x 10⁻³ m. What is the speed at which the gasoline moves through the fuel line?

### Solution for Problem 22

**23.** A patient recovering from surgery is being given fluid intravenously. The fluid has a density of 1030 kg/m³, and 9.5 x 10⁻⁴ m³ of it flows into the patient every six hours. Find the mass flow rate in kg/s.

### Solution for Problem 23

**24.** The aorta carries blood away from the heart at a speed of about 40 cm/s and has a radius of approximately 1.1 cm. The aorta branches eventually into a large number of tiny capillaries that distribute the blood to the various body organs. In a capillary, the blood speed is approximately 0.07 cm/s, and the radius is about 6 x 10⁻⁴ cm. Treat the blood as an incompressible fluid, and use these data to determine the approximate number of capillaries in the human body.
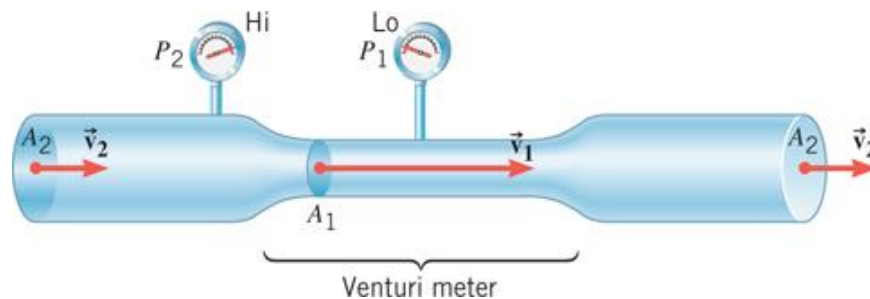
### Solution for Problem 24

**25.** An airplane wing is designed so that the speed of the air across the top of the wing is 251 m/s when the speed of the air below the wing is 225 m/s. The density of the air is 1.29 kg/m³. What is the lifting force on a wing of area 24.0 m²?

### Solution for Problem 25

**26.** The blood speed in a normal segment of a horizontal artery is 0.11 m/s. An abnormal segment of the artery is narrowed down by an arteriosclerotic plaque to one-fourth the normal cross-sectional area. What is the difference in blood pressures between the normal and constricted segments of the artery?

## Solution for Problem 26

**27.** A Venturi meter is a device that is used for measuring the speed of a fluid within a pipe. The drawing shows a gas flowing at speed $v_2$ through a horizontal section of pipe whose cross-sectional area is $A_2 = 0.0700$ m$^2$. The gas has a density of $\rho = 1.30$ kg/m$^3$. The Venturi meter has a cross-sectional area of $A_1 = 0.0500$ m$^2$ and has been substituted for a section of the larger pipe. The pressure difference between the two sections is $P_2 - P_1 = 120$ Pa. Find **(a)** the speed $v_2$ of the gas in the larger, original pipe and **(b)** the volume flow rate $Q$ of the gas.



Venturi meter

## Solution for Problem 27

**28.** An airplane has an effective wing surface area of 16 m$^2$ that is generating the lift force. In level flight the air speed over the top of the wings is 62.0 m/s, while the air speed beneath the wings is 54.0 m/s. What is the weight of the plane?

## Solution for Problem 28

**29.** One way to administer an inoculation is with a "gun" that shoots the vaccine through a narrow opening. No needle is necessary, for the vaccine emerges with sufficient speed to pass directly into the tissue beneath the skin. The speed is high, because the vaccine ($\rho = 1100$ kg/m$^3$) is held in a reservoir where a high pressure pushes it out. The pressure on the surface of the vaccine in one gun is 4.1 x 10$^6$ Pa above the atmospheric pressure outside the narrow opening. The dosage is small enough that the vaccine's surface in the reservoir is nearly stationary during an inoculation. The vertical height between the vaccine's surface in the reservoir and the opening can be ignored. Find the speed at which the vaccine emerges.

## Solution for Problem 29

**30.** A water bed for sale has dimensions of 1.83 m x 2.13 m x 0.229 m. The floor of the bedroom will tolerate an additional weight of no more than 6660 N. Find the weight of the water in the bed and determine whether the bed should be purchased.

### Solution for Problem 30

**31.** The *karat* is a dimensionless unit that is used to indicate the proportion of gold in a gold-containing alloy. An alloy that is one karat gold contains a weight of pure gold that is one part in twenty-four. What is the volume of gold in a 14.0-karat gold necklace whose weight is 1.27 N?

### Solution for Problem 31

**32.** A submersible pump is put under the water at the bottom of a well and is used to push water up through a pipe. What minimum output gauge pressure must the pump generate to make the water reach the nozzle at ground level, 71 m above the pump?

### Solution for Problem 32

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