1. Astronomers use density as a clue to the composition of distant objects. Judging by the orbits of its moons the mass of Saturn is found to be 5.68×10^{26} kg. (a) Use its mean radius 58 230 km to determine its mean density and specific gravity. (b) The density at its core is estimated to be around 15 g/cm^3 – what fraction of its total mass is Saturn's core if it is about twice the diameter of Earth?

2. Determine the density of a carbon-14 nucleus using a diameter of 5.8 fm. A neutron star is thought to be essentially a big ball of neutrons with a mass 1.4 times that of the Sun – how big is it?

3. How many kilograms of air is in the room?

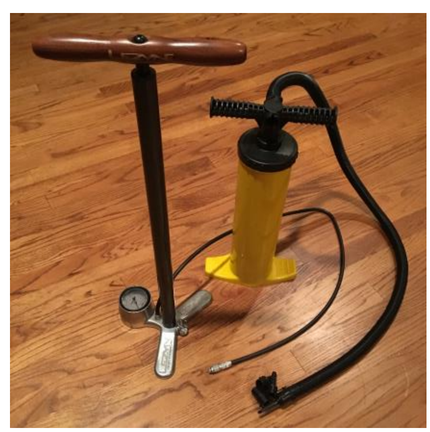
4. Given a tabletop that has width and length 2.0 ft by 4.0 ft, determine the force of the air on its surface.

5. A typical eardrum is about 8.0 mm in diameter. When listening to a quiet sound versus loud (75 dB vs. 110 dB) the amplitude of pressure change is from 0.1 Pa to about 6 Pa. (a) Find the force of air on the eardrum when there is no sound. (b) Find the change in this force at the sound levels described.

6. According to one source, a certain car has a weight of 4100 lb and four wheels that each have a "contact patch" (or tire footprint) of 37 square inches. The tires are inflated to 32 psi. (a) Calculate the normal force that acts on each tire. (b) Determine force per area for the footprint. (c) Calculate the force of the air *inside* the tire acting on the "other side" of the patch and compare.

7. While flying at an altitude around 10 km the cabin of an airplane is pressurized to 75 kPa. Given the atmospheric pressure is only 30 kPa determine the force acting on a circular window with diameter 30.0 cm to prevent it from blowing out.

8. Compare the two pumps shown, one for bicycles, the other for "inflatables" like a "floaty". Why the big difference in diameter? Explain.



9. In a certain hydraulic brake system the master cylinder has a diameter of 17 mm and the wheel cylinder has a diameter of 22 mm. Suppose a force of 50.0 N is applied on the piston of the master cylinder, which increases the pressure in the hydraulic lines and moves the piston at the wheel cylinder 0.10 mm. (a) What force acts on the piston at the wheel cylinder? (b) What distance must the piston in the master cylinder move?

10. Suppose you dive to the bottom of an eight foot pool. (a) Determine the change in pressure. (b) Determine the absolute pressure at the bottom of the pool.

11. A certain pool of water is a rectangular shape with dimensions 6.0 m by 10.0 m and depth 2.0 m. Determine the force of the water acting on each wall and the bottom of the pool.

12. A submarine dives to a depth of 100.0 m. Assume conditions within the sub are “normal” for the crew. Determine the force required to prevent a hatch of diameter 30.0 cm from “imploding”.

13. Suppose you connect an ideal pressure gauge to a rigid airtight container. Explain how it could be used to measure depth of water. Would it read positive or negative? Derive an equation for depth *h* in terms of gauge pressure *P* and any appropriate constants. A pressure reading of amount 32 psi would indicate what depth?

14. A cube of ice with sides length 3.0 cm and density 0.92 g/cm^3 is placed in a cylindrical beaker with diameter 12 cm partially filled with water. Assume that it floats with one face parallel to surface and ignore melting. (a) Determine the force of buoyancy on the cube. (b) Find the depth in the water. (c) What is the change in depth of water in the beaker? (d) Find the difference in pressure of air on top surface versus water on bottom surface.

15. A river barge is essentially a large rectangular shaped boat that can carry a load of around 1400 metric tons. Estimate the length if its width is limited to 11 m and its draft (depth in water) is 3.0 m. If the actual length is 60.0 m, what is the mass of the barge itself?

16. Imagine turning a student desk into a boat – turn it upside down and create sides. (a) Given that the overall volume of space beneath the desk is about 0.60 m^3, how many people of mass 75 kg could it hold without sinking more than halfway into the water? (b) What if it were floating in a pool of mercury?

17. An iron (SG = 7.8) sphere of radius 5.00 cm is lifted from the ocean (density of seawater = 1020 kg/m^3). (a) Find the normal force if it rests on the bottom. (b) What force is needed to accelerate it upward 2.0 m/s^2? (c) What is its initial acceleration if it is dropped from rest and sinks? (d) If it falls through the water at a constant speed (terminal velocity) what is the drag acting on it?

18. Two cylinder have the same diameter and height and each one sinks. One sphere is made of solid aluminum. The other is an aluminum can filled with sand and sealed. Compare the force of buoyancy on the two objects. What if the aluminum can is filled with air and sealed?

19. Determine the mass of a balloon using an electronic balance. Then let the air out and determine the mass of the rubber of the balloon. If you subtract the values is this the mass of the air? Use a motion detector to determine the acceleration of the balloon in "freefall" when its speed is zero. Find mass!

20. It is sometimes said that if you had an ocean big enough Saturn could float in it. How deep and how wide does this ocean need to be? Density of seawater is 1020 kg/m^3. (Challenging volume determination!)

21. A 5/8 inch garden hose is used to fill a 5 gallon bucket of diameter 26 cm. The water leaves the hose moving at speed 1.1 m/s. (a) Find the time to fill the bucket. (b) Find the speed of the rising water level in the bucket.

22. A hypodermic is used to deliver an injection of 1.8 mL of medicine into a vein in 4.0 s. The diameters of the syringe's plunger and the needle are 1.25 cm and 0.20 mm. (a) Find the speeds of the plunger and the medicine leaving the needle. (b) If the gauge pressure in the vein is 18 mm-Hg, what minimum force is required on the plunger?

23. Consider a pool toy with a plunger diameter 2.0 cm and outlet diameter 0.4 cm. To fire at an enemy, the plunger is depressed 6.7 cm in 0.50 s. (a) Find the speed of the projectile water. (b) Determine the volume and mass flow rates.

24. Consider the previous problem. (a) Find the kinetic energy of the water projectile. (b) Estimate the force required to fire the weapon. (c) Find the pressure in the cylinder during firing. (d) Write a symbolic expression for this pressure.

25. Repeat problem 24 but this time use Bernoulli's principle.

26. A fire hose of diameter 6.4 cm is connected to a hydrant. The nozzle has diameter 3.0 cm and sprays water at a rate 35 L/s. (a) Determine the speed of the water at the hydrant and at the nozzle. (b) Determine the pressure necessary at the hydrant. (c) Find the new flow rate and speeds if the nozzle is spraying from a ladder 10.0 m above the hydrant.

27. Toricelli's theorem states that fluid leaving a container through an opening at the bottom has a speed given by $v = (2gh)^{½}$, where h is the distance below the water level in the container. Use Bernoulli's equation to show why this works and show what assumptions or conditions are necessary.