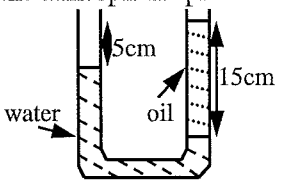
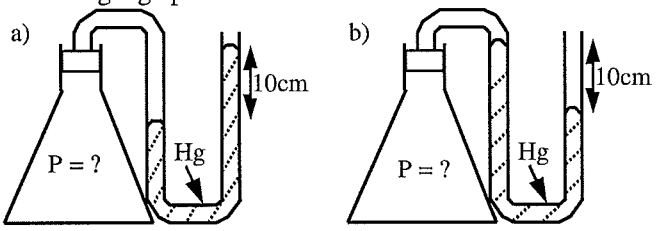
Fluid Mechanics (ρ_{Hg}= **13600 kg/m^3**, ρ_{air} = **1.29 kg/m^3**)

Fluid at rest: fluid pressure:

1. What is the absolute pressure a) in atm, and b) in pascal, at the ocean floor 3800 meters beneath the surface where the Titanic wreckage lies? ($\rho_{seawater}$ = 1025 kg/m^3)
2. Intravenous infusion often makes use of gravity. Assuming the fluid density is 1000 kg/m^3, at what height h (from the top of the fluid to the needle entering the vein) should the bottle be placed so the liquid pressure is a) 50 mm-Hg, b) 400 mm-H_2O at the needle entering the vein? c) If the blood pressure is 16 mm-Hg above the atmospheric pressure, how high should the bottle be placed so that the fluid just barely enters the vein?
3. The gauge pressure in each of the four tires of an automobile is 2.5 atm. If each tire has a "footprint" of 0.025 m^2, estimate the mass of the car.
4. Water and then oil are poured into a U-shaped tube, open at both ends, and do not mix as shown on the right. Find the density of the oil.

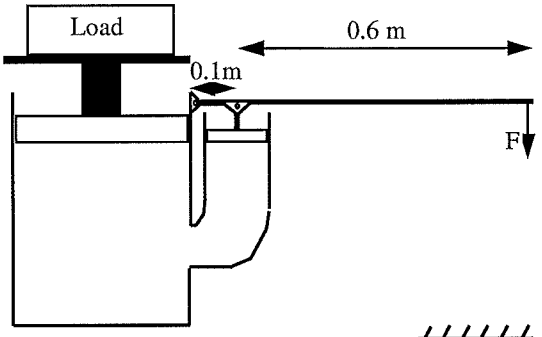


5. How high would the level be in a barometer at the top of a mountain where the atmospheric pressure is 0.7atm if the fluid in the barometer has a density of 1.5g/cm^3?
6. Water is to be pumped to the top of a 200-m high skyscraper. What gauge pressure is needed in the water line at the base of the building to raise the water to this height? (Ignore frictional and viscous effects.)
7. An open-tube manometer is used to measure the pressure of a confined gas as shown on the right. Find the pressure of the confined gas for a) and b) in cmHg and in Pascals.



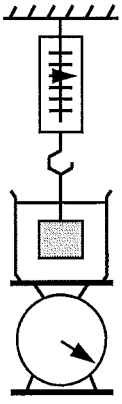
Fluid at rest: Pascal's principle:

8. In a hydraulic lift, the diameters of the pistons are 0.1 m and 0.5 m. A car weighing 12000N is to be lifted by the force of the large piston. a) What force is to be applied to the small piston? b) When the small piston is pushed down by 0.02 m, how far is the car lifted?
9. The two pistons shown to the right have radii of 0.2 m and 0.08 m. In the absence of friction, determine the force F required to support the 600-kg load.



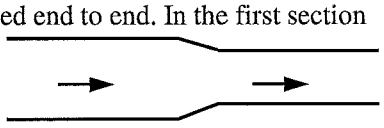
Fluid at rest: buoyant force

10. The specific gravity of a piece of wooden block is 0.5, whereas that for gasoline is 0.68. What fraction of the wooden block is above the surface of gasoline when the wooden block floats in gasoline?
11. What fraction of a cork will be submerged when it floats in oil? (ρ_{cork}=240 kg/m^3, ρ_{oil}=800kg/m^3)
12. A 2-kg copper block has a 1.7 kg apparent mass when submerged in a liquid. What is the density of this liquid? (ρ_{copper} = 8900 kg/m^3)
13. A 0.4-kg beaker containing 1.2 kg of water rests on a scale. A 2-kg block of gold (SG_{gold} = 19.3) is suspended from a scale and completely submerged in the water as shown on the right. Find the readings (in kg) of a) the top scale, and b) the bottom scale.
14. An empty balloon has a mass of 0.005 kg. The balloon is then filled with helium gas at a density of 0.18 kg/m^3. At this density the spherical balloon has a radius of 0.3 m. If the filled balloon is fastened to a light vertical thread, what is the tension in the thread? (ρ_{air} = 1.29 kg/m^3)



Flowing fluid: 15 to 22: Neglect the effects of friction, turbulence, and viscosity.

15. A garden hose of inner diameter 2.4 cm carries water at 0.4 m/s. The nozzle at the end has a diameter 0.4 cm. How fast does the water move through the nozzle?
16. A hose of inner radius 0.01 m is used to fill a 0.5m × 2m × 0.8m rectangular tub. If the water flows through the hose with a speed of 2 m/s, how long does it take to fill the tub?
17. A liquid (ρ_{liquid} = 1100 kg/m^3) flows through two horizontal sections of tubing joined end to end. In the first section the cross-sectional area is 10 cm^2, the flow speed is 2 m/s, and the pressure is 10^5 pascals. In the second section the cross-sectional area is 5 cm^2. Calculate the second section's a) flow speed and b) pressure.



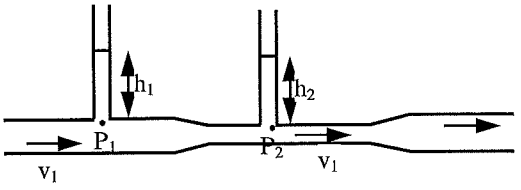
18. What is the volume rate of flow of water from a 0.01-m-radius faucet if the pressure head is 20 meters high?
19. Hurricanes have sustained winds above 74 mph (33 m/s). What is the net force on a 400-m^2 flat roof of a house when a hurricane blows at 33 m/s over this house? Is this net force an upward or downward force?

Physics Practice Problems — Fluid Mechanics

Flowing fluid: 15 to 22: Neglect the effects of friction, turbulence, and viscosity.

20. What is the lift force due to Bernoulli's principle on a pair of wings of total area 100 m^2 if the air passes over the top and bottom surfaces at speeds of 300 m/s and 260 m/s, respectively? (ρ_{air} = 1.29 kg/m^3)

21. A Venturi meter is used to measure the speed of water flow in a pipe of cross-sectional area 0.01 m^2. A constriction (of cross-sectional area 0.002 m^2) is put in the pipe. Two vertical tubes, open to the atmosphere, rise from two points, one of which is in the constriction.



a) Compare h_1 and h_2 . Which one should be higher?

b) Let's say that h_1 = 1.5 m and h_2 = 0.6 m, find P_1 , P_2 and the flow speed v_1 and v_2 in the pipe.

22. A pump, submerged at the bottom of a well that is 30 meters deep, is used to pump water up to faucets in a house. The highest level faucet is 10 m above the top of the well. If the average gauge pressure at the pump is 403,700 Pa, the radius of the pipe connected to the pump is 0.03m, and the radius of the faucet opening is 0.01m. Find the flow speed when the highest faucet in the house is open.