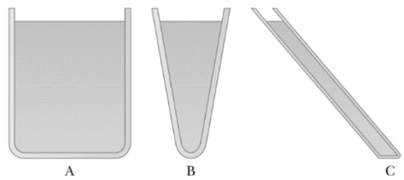
AP Physics 1
Unit 8 Practice Exercises

Directions: Show the steps required to arrive at the answer. Work out the problems on separate page.

8.1 – Fluids

1. Is peanut butter a fluid? Briefly justify your answer.

2. Rank the pressure at the bottom of the containers shown:



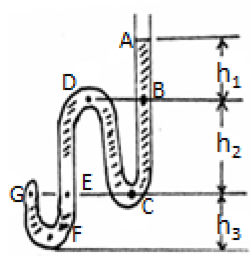
3. Briefly describe why you feel your ears "pop" when you drive up a mountain.

4. A 8 kg cat stands on a horizontal surface.

a) Suppose the average density of cat matter is 800 kg/m^3. What is the volume of the cat?
b) What is the pressure the cat exerts on the surface if each of the cat's paws has a surface area of .003 m^3?

5. The four tires of a Hyundai Elantra are inflated to a gauge pressure of $\mathbf{2.0x10^5}$ Pa. Each tire has a surface area in contact with the ground of .025 m^2. Determine the weight of the car.

6. The tube shown is filled some liquid. The pressure at point A is P_A. Find the pressure at the labeled points.



7. A barber cuts a customer's hair without making small talk in order to maximize their tip. The barber applies a force of 250 N to a hydraulic piston with a surface area of .02 m^2. What is the maximum mass the barber can raise with the piston?

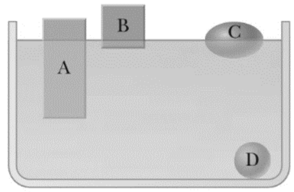
8. The weight of Earth's atmosphere exerts a pressure of $\mathbf{1.01x10^{-5}\ Pa}$ at sea level. Estimate the weight of the earth's atmosphere. ($\boldsymbol{R_E = 6.4x10^{-6}\ m}$)

8.2 – Buoyancy

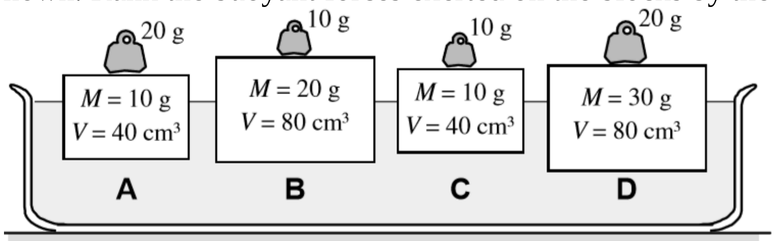
1. A fisherman is in a canoe floating on a small pond. He drops a bass overboard into the pond. What happens to the level of the pond?

2. A stone has a radius of 3 cm and density of 0.4 g/cm^3. What force is required to hold it completely under water?

3. Rank the densities of the four objects shown.



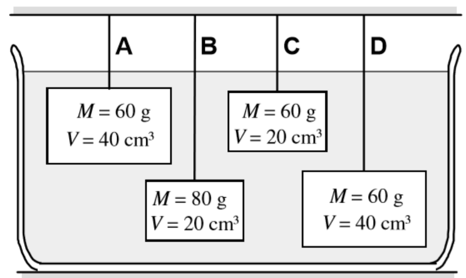
4. Wood blocks that have different masses and different volumes are floating in water. On top of these blocks are additional masses as shown. Rank the buoyant forces exerted on the blocks by the water.



5. Blocks that have different masses and volumes are suspended by strings in water. The blocks are at two different depths below the surface as shown.

a) Rank the buoyant force exerted on the blocks by the water.

b) Rank the tensions in the strings the block are attached to.



6. A 20.0-kg lead mass rests on the bottom of a pool.

a) What is the volume of the lead?

b) What buoyant force acts on the lead?

c) What is the normal force acting on the lead

7. An stapler weighs 12 N in air and 10 N when submerged in water.

a) What is the stapler's volume?

b) What is the stapler's density?

8. Ice ($\boldsymbol{\rho_{ICE} = 920\frac{kg}{m^3}}$) floats in the ocean $\boldsymbol{\rho_{SEA\,WATER} = 1030\ \frac{kg}{m^3}}$) .

a) What fraction of the ice is submerged?

b) The ice melts completely. What happens to the level of the water?

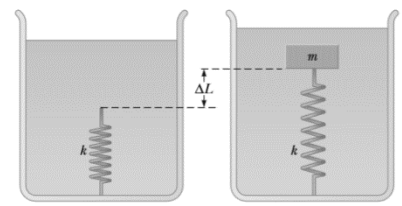
9. A boat is 1.00 m wide and 2.00 m long. A person steps into the boat and it sinks an additional 4.00 cm into the water. What is the person's mass?

10. A boat of mass M can displace a maximum volume of V_B. The boat is floating on water of density ρ_W and is loaded with creates of average density ρ_C. The crates are cubes with edge length of s. Derive an expression for the number of crates the boat can load without exceeding its maximum displaced volume.

11. A hollow sphere floats exactly half submerged in water of density 1000 kg/m^3. The outer radius of the sphere is 15 cm and the inner radius is 14 cm. Calculate the density of the material of the sphere.

12. A steel cable holds a 200 kg submarine 4 meters below the surface of the ocean (the specific gravity of saltwater is 1.03). If the volume of water displaced by the submarine is 0.1 m^3, what is the tension in the cable?

13. A light spring of force constant k = 200 N/m rests vertically on the bottom of a beaker of water as shown. A 5.00-kg block of wood ($\rho = 650\frac{kg}{m3}$) is connected to the spring, and the block–spring system reaches equilibrium. What is the distance, ΔL, that the spring is compressed?



14. This question is about Archimedes' Principle.

a) Show that the pressure at a depth h below the free surface of a liquid of density ρ is given by

$$\rho = \rho_{ATM} + \rho g h$$

b) Suggest what, if anything, will happen to the pressure at a depth h below the free surface of the liquid in a container, if the container:

i. falls freely under gravity

ii. is accelerated upwards with acceleration

c) A block of wood floats in water with 75% of its volume submerged. The same block when floating in oil has 82% of its volume submerged. The density of water is 1000 kg/m^3. Calculate:

i. the density of the wood

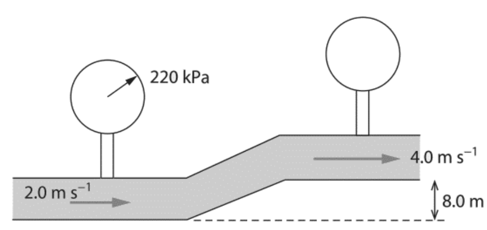
ii. the density of the oil.

8.3 – Fluid Dynamics

1. In a shower, water enters the shower head through a tube of diameter 1.2 cm with a speed of 1.1 m/s. The shower head has 30 small holes, each of diameter 0.20 cm. Calculate the speed with which the water exits one of these holes.

2. Water of density is pumped out of a tank though a hose of radius 1.2 cm. The water in the hose has a constant speed of 3.8 m/s. The water is raised a vertical distance of 4.0 m before being ejected into the surroundings. Estimate the power of the pump.

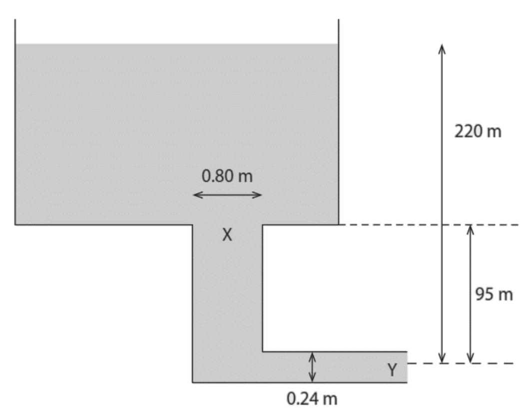
3. Oil of density 850 kg/m^3 flows in the pipe shown below. Calculate the pressure shown by the gauge on the upper side of the pipe.



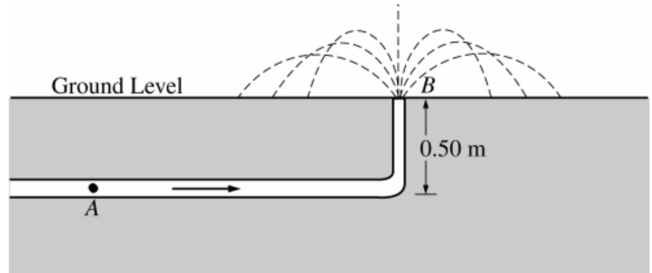
4. In the diagram below shown the exit at Y is opened so that Y is exposed to atmospheric pressure. ($\rho_{WATER} = 1000\frac{kg}{m^3}$)

a) Calculate the speed with which the water leaves the exit Y

b) Calculate the pressure at X.

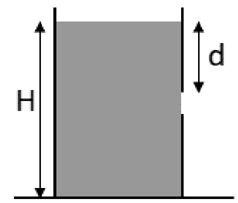


5. An underground pipe carries water to a fountain at ground level. At point A, the pipe has a cross-section are of $1.0x10^{-4}$ m^2. At ground level, the pipe has a cross-section area of $0.5x10^{-4}$ m^2. The water leaves the pipe at point B at a speed of 8.2 m/s.



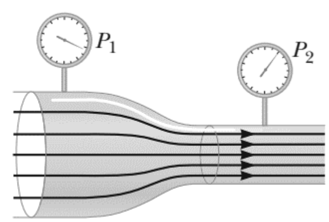
a) Calculate the speed of the water at point A.
b) Calculate the absolute pressure in the pipe at point A.
c) Calculate the maximum height above the ground the water reaches.

6. Water exits a tank horizontally from a hole at a depth *d*. The water level in the tank is *H* and may be considered to be constant. Determine *d* in terms of *H* so that the water lands on the ground at the largest possible distance from the base of the tank.



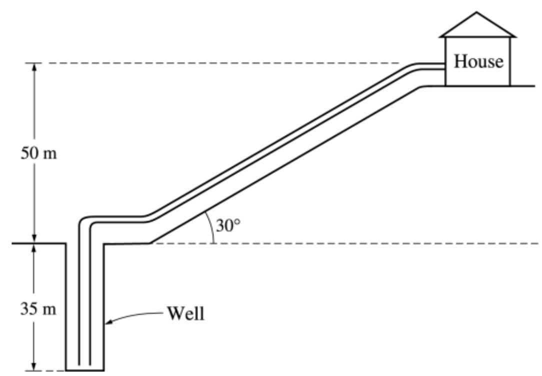
7. Suppose the venturi tube shown is used to measure the flow rate of gasoline ($\rho = 700\ kg/m^3$) through a hose having an outlet radius of 1.20 cm. The inlet tube has a radius of 2.4 cm The pressure different is measured to be $P_1 = P_2$=1.2 kPa.

a) Calculate the speed of the gasoline as it leaves the hose.
b) Calculate the fluid flow rate.



8. A pump, submerged at the bottom of a well that is 35 m deep, is used to pump water uphill to a house that is 50 m above the top of the well, as shown. The density of the water is 1,000 kg/m^3. All pressures are gauge pressures and the water can be treated as an ideal water.

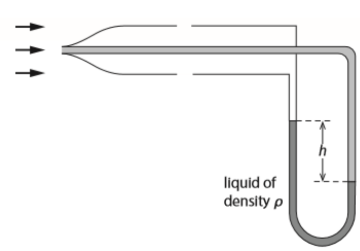
a) Residents of the house use 0.35 m^3 of water each day. The day's pumping is completed in hours each day.
   i. Calculate the minimum work required to pump the water used per day.
   ii. Calculate the minimum power rating of the pump.



b) The average pressure the pump actually produces is $9.20x10^5\ N/m^2$. Within the well the water flows at 0.50 m/s and the pipe has a diameter of 3.0 cm. At the house the pipe diameter is 1.25 cm.
   i. Calculate the flow velocity when a faucet in the house is open.
   ii. Calculate the minimum pressure at the faucet.

9. A Pitot-Prandtl tube is used to measure the speed of an aircraft. The liquid in left-hand column has a density of ρ. The difference in the liquids levels is h.

a) Explain why the liquid in the right-hand column is lower than in the left-hand column.
b) Show the that the flow speed is given by $v = \frac{2\rho g h}{\rho_{air}}$



*10. Water comes out of a tap of cross-sectional area 1.4 cm^2. After falling a vertical distance of 5.0 cm, the cross-sectional area of the water column has been reduced to 0.60 cm^2. Calculate the volume of water per second delivered by the tap.