Term Name

Class Name

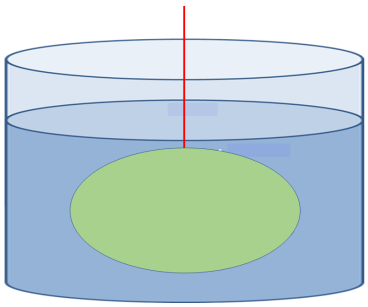
Yun Zhang College Physics 1 Problems - Fluid Statics

Name:

Date:

Section:

Question 1 **(1 point)**



Archimedes Principle - Upward Tension Additional Force

As shown in the above figure, a solid object has a density of 1200 kg/m^3 and a volume of 8.40x10^-5 m³. It is lowered on a string into water and completely submerged without touching the container. The density of water is 1000 kg/m^3.

Keep 3 decimal places in all answers. (Don't use scientific notations.)

Without the string, would the solid object sink in water or float in water? No submission.

(a) What is the magnitude of the weight (in Newtons) of the object ?

(b) What is the direction of the buoyant force exerted on the solid object by water?

a. either upward or downward depending on whether the object floats or sinks

b. downward

c. upward

Calculate the magnitude of the buoyant force (in Newtons).

(c) What is the direction of the tension force in the string that exerts on the solid object?

a. downward

b. upward

c. no tension is needed

Draw a force diagram (as practice, no submission) including all the forces on the solid object.

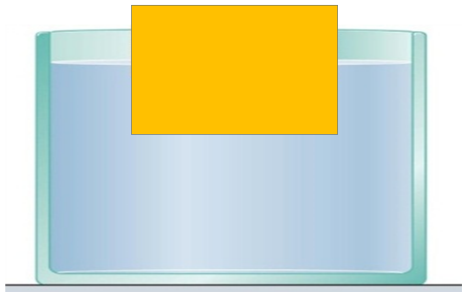
Find the magnitude of the tension force (in Newtons) in the string.

(d) If the string is cut, find the **magnitude of** the ball's acceleration (in m/s^2) right after the string is cut.
What is the direction of the ball's acceleration?

a. downward

b. upward

Question 2 **(1 point)**



Archimedes Principle - Downward Push Additional Force

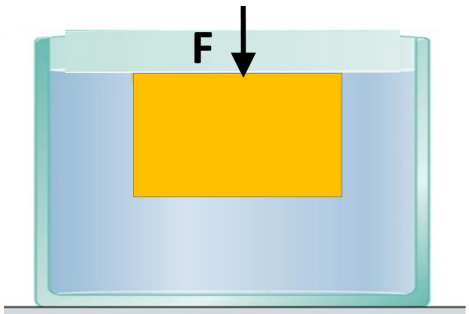
As shown in the above figure, a solid block with a mass of 6.00 kg and a density of 720.00 kg/m^3 kg/m^3 floats quietly in water (density of watser = 1000 kg/m^3.)

(a) Calculate the total volume (in m^3) of the block. Keep 4 decimal places in all answers. **(Don't use scientific notations.)**

Draw a force diagram (as practice, no submission) including all the forces on the solid object.

(b) Find the volume (in m^3) of the block that is **under** the water surface. Keep 4 decimal places in all answers. **(Don't use scientific notations.)**

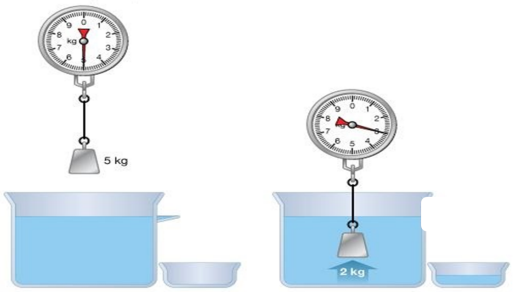
A hand pushes on the top of the block downward till the block is just completely submerged and then holds the block with a downward force **F**.



(c) Find the magnitude of the buoyant force (in Newtons) in this new situation. Keep 2 decimal places.

(d) Draw a force diagram (as practice), and find the magnitude of force F in Newtons. Keep 2 decimal places.

Question 3 **(1 point)**



Apparent Weight in Air and Water

This problem is similar to the "Crown" example in lecture (and the "pendent" activity in Archimedes Principle Lab.)

Archimedes' principle can be used to ***find the*** **density of a solid**.

A rock with a mass of 535.00 g *in air is found to have an apparent mass of* 340.00 g *when completely submerged in water. The density of water is 1000 kg/m^3. 1000 grams = 1 kg.*
The gravitational acceleration is 9.8 m/s^2.

Draw a force diagram in AIR including all the forces on the rock. (NO submission)

Draw a force diagram including all the forces on the rock when it is submerged in water. Apply Newton's laws to relate the magnitudes of the forces to obtain an equation. (Hint: the apparent weight is equal to the magnitude of the tension force in the string holding the rock in water)

(a) What is the magnitude of the buoyant force in Newtons? Keep 2 decimal places.

(b) What is the volume of the rock ?
Hint: use the buoyant force formula for a completely submerged object.

The volume is a small value, **report it in 10^{-4} *m^3* .** For example, if your volume value is ***0.00032 m^3 ,*** write it as ***3.2*** $\times$ **10^{-4} m^3. Submit 3.2 as your answer.**

(c) What is the rock*'s density in kg/m^3 ? Keep 2 decimal places. Don't use scientific notation.*

Archimedes' principle can be used to ***find the density of a fluid*** *as well as that of a solid. Suppose a chunk of iron with a mass of* 390.00 g *in air is found to have an apparent mass of* 320.00 g *when completely submerged in an unknown liquid. 1000 g = 1 kg.*

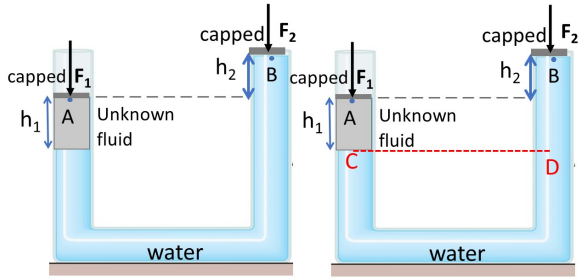
(d) What is the magnitude of the buoyant force in Newtons? Keep 2 decimal places.

(e) What is the volume of the iron chunk, using its density of 7.8 $\times 10^3$ kg/m^3?

The volume is a small value, **report it in 10^{-5} *m^3* .** For example, if your volume value is ***0.000052 m3 ,*** write it as ***5.2*** $\times$**10^{-5} m^3. Submit 5.2 as your answer.**

(f) What is the *fluid's density in kg/m^3 ? Keep 2 decimal places. Don't use scientific notation.*
Hint: use the buoyant force formula for a completely submerged object.

Question 4 (1 point)



Pressure vs Depth - U Shaped Tube Two Fuids 3

As shown in the left figure, Water is first poured into a U-tube, then some unknown fluid is poured into the LEFT arm. Then both arms are tightly capped (the cross-sectional area of both caps is 0.011 m^2), and forces **F1**= 9.4 N and **F2** = 7.3 N are exerted on the caps, respectively. When equilibrium is reached, the right cap is higher than the left cap. h1 = 0.38 m, h2 = 0.24 m The density of water is 1000 kg/m^3.

(a) What is the pressure in Pa at point A (just below the left cap)?

(b) What is the pressure in Pa at point B (just below the right cap)?

(c) Find the density of the unknown fluid.

The most important step in solving a U-Shaped Tube problem is to identify two points (one on each side) that have the same pressure. These two points must be at the SAME HORIZONTAL Level in the SAME FLUID.

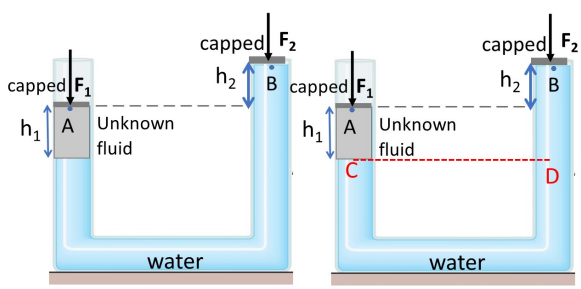
Points C and D in the figure on the right are at the same horizontal level and in the same fluid (unknown fluid). $\mathbf{P_C = P_D}$

Apply the **pressure varying with depth equation** to write P_C in terms of P_A, density of unknown fluid, height h1, and other relevant quantities, and to write P_D in terms of P_B, height from B to D, density of water, and other relevant quantities..

Solve for the density of unknown fluid..

What is the pressure at point C in Pa? Don't use scientific notation.

What is the pressure at point D in Pa? Don't use scientific notation.



Question 5 **(1 point)**

The Concept of Density

(a) A rectangular gasoline tank can hold 57.00 kg *of gasoline when full. What is the depth (in meters) of the tank if it is 0.500-m wide by 0.900-m long? The density of gasoline is 680 kg /m^3.*

The Concept of Pressure

(b) As a woman walks, her entire weight is momentarily placed on one heel of her high-heeled shoes. Calculate the pressure exerted on the floor by the heel if it has an area of 1.80 cm² and the woman's mass is 57 kg*. Express the pressure in 10^6 Pa (N/m^2)*

for example, if the pressure is 6800000 = 6.8 $\times 10^6$ Pa, enter just 6.8.

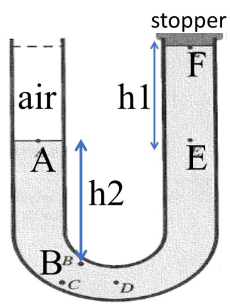
(c) Nail tips exert tremendous pressures when they are hit by hammers because they exert a large force over a small area. What force must be exerted on a nail with a circular tip of 0.80 mm *diameter to create a pressure of 3.00* $\times$ 10^9 N/m^2 ?

First calculate the area of the circular tip, express it in 10^{-6} m^2.

For example, if the area is 0.0000068 = 6.8 $\times 10^{-6}$ m^2, enter just 6.8.

Calculate the force. DON"T use scientific notation.

Question 6 **(1 point)**



Pressure varies with depth - U-shape Tube

The figure shows a U-tube containing water. The right side of the tube is sealed with a stopper (there is no air between the stopper and the water surface), and on the left side the water lever is indicated by letter A and is open to the air. The atmospheric pressure is 1.013 $\times 10^5$ Pa. Points A and E are at the same horizontal level. Point F is above point E by h1= 0.25 m. Point B is below point A by h2 = 0.48 m. The density of water is 1000 kg/m^3.

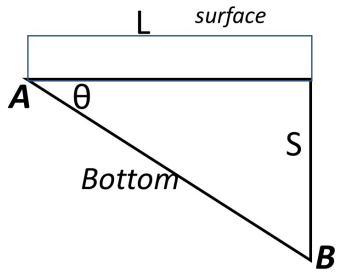
(a) What is the pressure at point E in 10^5 Pa? Keep 3 decimal places.

for example, if the pressure is 682500 = 6.825 $\times 10^5$ Pa, enter just 6.825

(b) What is the pressure at point **F** in 10^5 Pa? Keep 3 decimal places.

(c) What is the pressure at point **B** in 10^5 Pa? Keep 3 decimal places.

Question 7 **(1 point)**



Pressure varies with depth -swimming pool

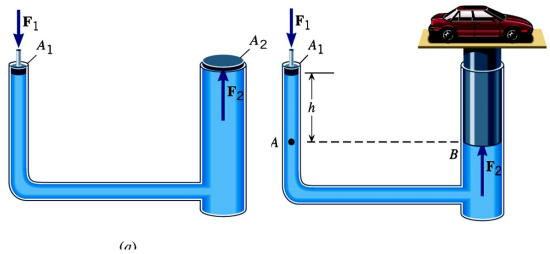
As shown in the figure, measured along the surface of the water, a swimming pool has a length of L = 19.00 m. The bottom of the pool slopes downward at an angle of θ = 17.0° below the horizontal, from one end to the other.

What is the dimension labeled "S"?

What is the dimension labeled Bbottom"?

By how much does the pressure at point B exceed the pressure at point A? (Calculate P_B - P_A)
Density of water = 1000 kg/m^3. Don't use scientific notation.

Question 8 **(1 point)**



U_Shaped Tube Hydraulics

A hydraulic system is filled with water, and the two arms are capped. The caps have negligible mass and are watertight, and can freely slide up and down the tubes. The cross-sectional area of the left arm is A1= 0.015 m² and the cross-sectional area of the right arm is A2 = 0.220 m² The density of water is 1000 kg/m^3.

(a) In the left Figure, the force exerted on the left cap is F1 = 430.0 N . What is the magnitude of the force F2 (in Newtons) on the right cap? The two caps are at the same height.

(b) In the right figure, the force exerted on the left cap is still F1 = 430.0 N but a force F2 = 10900.0 N on the right side is needed to lift the car (and the piston). Find the height h (in meters) in the figure.

The most important step in solving a U-Shaped Tube problem is to identify two points (one on each side) that have the same pressure. These two points must be at the SAME HORIZONTAL Level in the SAME FLUID.

Points A and B in the figure on the right are at the same horizontal level and in the same fluid (unknown fluid). $\mathbf{P_A = P_B}$

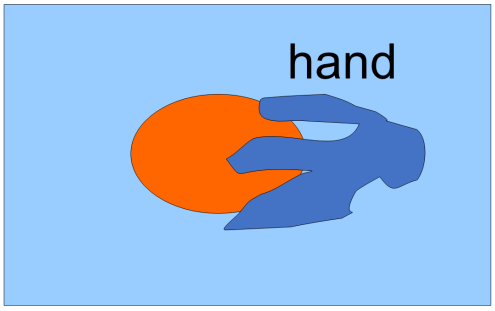
Apply the **pressure varying with depth equation** to write PA in terms of F1, A1, density of water , height h, and other relevant quantities, and to write PB in terms of F2, A2.

Solve for the height h.

What is the pressure at point A in Pa? Don't use scientific notation.

What is the pressure at point B in Pa? Don't use scientific notation.

Question 9 **(1 point)**



Archimedes' Principle - Object Held and Released

As shown in the above figure, a solid object with a mass of 3.00 kg and a volume of 0.0049 m^3 is held by a hand completely immersed in water (density of water = 1000 kg/m^3).

(a) Find the magnitude of the buoyant force (in Newtons). Keep 2 decimal places.

(b) Calculate the magnitude of the weight (in Newtons) of the object.

(c) What is the direction of the force exerted by the hand on the object?

a. downward

b. upward

(d) Draw a force diagram (as practice), and find the magnitude of the force (in Newtons) exerted on the object by the hand. Keep 2 decimal places.

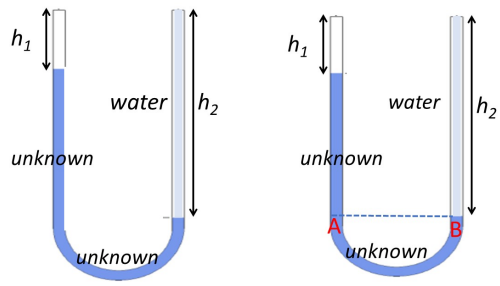
(d) The hand releases the object. In which direction does the object go?

a. downward

b. upward

Find the magnitude (in m/s^3) the object's acceleration right after it is released.

Question 10 **(1 point)**



Pressure vs Depth - U Shaped Tube Two Fluids 2

As shown in the figures, a U-shaped tube open to the air at both sides contain some unknown liquid. Then **water** (density = 1000 kg/m ^{3}) fills the **Right** arm of the U-tube (there is no intermixing between the two liquids). When equilibrium is reached, h1 = 0.20 m, and height of water h2 = 0.55 m. The atmospheric pressure is 1.013 $\times 10^5$ Pa. What is the density of the unknown liquid?

(a) Before solving for the density of the unknown fluid, Use your intuition: look at the figure and compare the heights of the two fluids, how do their densites compare?

a. denisity of unknown fluid < Densty of water

b. denisity of unknown fluid = Densty of water

c. denisity of unknown fluid > Densty of water

The most important step in solving a U-Shaped Tube problem is to identify two points (one on each side) that have the same pressure. These two points must be at the SAME HORIZONTAL Level in the SAME FLUID.

Points A and B in the figure on the right are at the same horizontal level and in the same fluid (unknown fluid). (Point B is also at the btttom of water) $\mathbf{P_A = P_B}$

Apply the **pressure varying with depth equation** to write PA in terms of density of unknown fluid (and other relevant quantities), and to write PB in terms of density of water and other relevant quantites.

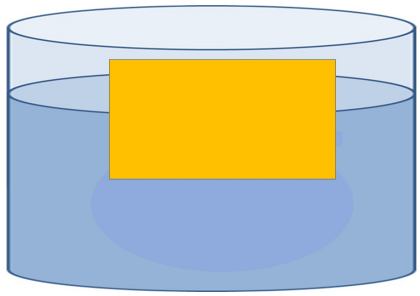
Solve for the density of the unknown fluid.

What is the pressure at point A in 10^5 Pa? Keep 3 decimal places.

For example, if the result is 123456 Pa = 1.23456 $\times$105 Pa, enter 1.235.

What is the pressure at point B in 10^5 Pa? Keep 3 decimal places.

Question 11 **(1 point)**



Archimedes Principle - Floating Objects

The above figure shows a solid object floating in a fluid, with part of its volume above the surface of the fluid and the rest of its volume submerged in the fluid under the surface.

The general approach to such problems is:
Step 1. Draw a force diagram of the solid object, idenfy all the forces acting on it and their directions.

Step 2. Apply Newton's Laws (either the first law or the second law) to write an equation relating the magnirudes of the forces in step 1.

Step 3. Apply the formula of the buoyant force for a floating object. Pay attention to what density and what volume are relevant to the buoyant force.

Also write the mass of the solid object in terms of its density and volume. Pay attention to what density and what volume are relevant to the mass.

Step 4. Solve the obtained equation for unknown quantities.

(a) *What percentage of ice (density = 917 kg/m^3) is submerged when it floats in freshwater, given the density of water at 0°C is very close to 1000 kg/m^3?*

(b) *What percentage of a soid (density =* 810.0 kg/m^3 *kg/m^3) is submerged when it floats in a fluid whose density is* 1190.0 kg/m^3 *kg/m^3?*

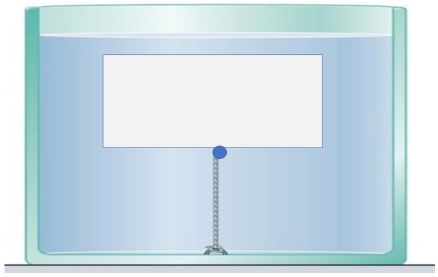
(c) *What is the average density (in kg/m^3) of an object that floats with 69.00% of its volume* ***under*** *a fluid whose density is* 1215.0 kg/m^3 *kg/m^3?*

(d) *What is the average density (in kg/m^3) of an object that floats with* 71.00% *of its volume* ***above*** *a fluid whose density is* 1100.0 kg/m^3 *kg/m^3?*

(e) *Find the density (in kg/m^3) of a fluid in which a solid having a density of* 860.0 kg/m^3 *kg/m^3 floats with* 80.00% *of its volume* ***submerged.***

(f) *Find the density (in kg/m^3) of a fluid in which a solid having a density of* 850.0 kg/m^3 *kg/m^3 floats with* 32.00% *of its volume* ***above*** *the surface of the fluid.*

Question 12 **(1 point)**



Archimedes Principle - Downward Tension Additional Force

As shown in the above figure, a hollow plastic box is held below the surface of fresh water lake by a cord anchored to the bottom of the lake. The box has a volume of 0.075 m^3 , and the tension in the cord is 355.0 N. The density of water is 1000 kg/m^3.

Keep 3 decimal places in all answers. **(Don't use scientific notations.)**

(a) Calculate the magnitude of the buoyant force (in Newtons).

What is the direction of the buoyant force exerted on the solid object by water?

a. either upward or downward depending on whether the object floats or sinks

b. upward

c. downward

(b) Whbat is the direction of the tension force in the string that exerts on the hollow box? Hint: A tightened string can only pull but can't push.

a. upward

b. downward

c. no tension is needed

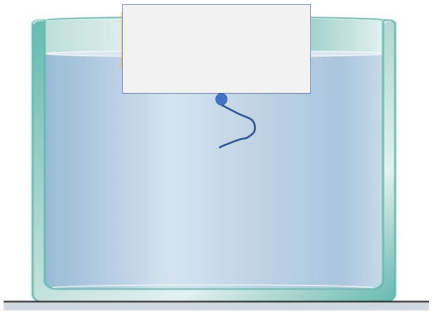
Draw a force diagram (as practice, no submission) including all the forces on the solid object.

(c) Find the magnitude of the weight (in Newtons) of the box.

Find the mass (in kg) of the box.

Calculate the density (in kg/m^3) of the box.

The cord breaks and the box rises to the surface, as shown in this figure.



(d) When the box comes to rest, find the volume (in m^3) of the box that is **under** the water surface.