AP Physics Study Guide Chapter 10 Fluid Mechanics **Name________________**

Read the indicated sections in chapter 10 and complete the following.

<u>Section 2</u>

Write the expression for the density of a substance, defining all terms. Include the SI units for density.

<u>Section 3</u>

Write the expression for the pressure exerted by a fluid, defining all terms. Include the SI units for pressure.

What are the two important facts about the pressure exerted by fluids

1) 2)

Write the expression that relates pressure exerted by a liquid as a function of depth, defining all terms.

The area A of the liquid ____________ affect the pressure at a given depth. The fluid pressure is

directly proportional to the ____________ of the liquid and to the __________ within the liquid.
The expression on the AP formula sheet includes P_0 which is the atmospheric pressure on the top of the fluid $P=P_0 + \rho gh$. You may also need to calculate the pressure difference within a liquid in

which case you would use the expression ____________________.

<u>Section 4</u>

What is the value for atmospheric pressure in Pascals (N/m^2):

Write the expression relating absolute pressure P, atmospheric pressure (P_A or P_0) and gauge pressure P_G.

Section 5

Briefly state how the pressure at the bottom of a lake is calculated using the two components that affect it.

Write Pascal's principle

Section 7

For a submerged diver floating in equilibrium at a depth in a liquid the upward _____________ force balances the downward _______________ force. The buoyant force on the diver occurs because the ___________ pressure on the bottom of the diver is ___________ than the _________________ pressure on the top of the diver (see Fig 10-11). Write the four step derivation of the buoyant force

1) 2) 3) 4)

Write Archimedes' principle which explains the cause of this buoyant force:

Do Example 10 – 7

____

Examine Fig 10-15. Why is the buoyant force greater when the log is fully submerged than when it is floating on top of the water?

Explain briefly how the density of an object that is floating on water partially submerged is related to the density of water and how that determines the fraction of the object that is submerged.

<u>Section 8</u>

Up to now the liquid has been static. Now you will read about fluids in motion – fluid dynamics. Explain the difference between streamline (laminar) flow and turbulent flow. Include a diagram.

Draw Figure 10-20 here, labeling all parts of the diagram as shown.

Write the continuity equation (equation 10-4b) for an incompressible fluid of constant density. Define all terms.

What does the product Av represent? Include the SI units for this quantity.

The continuity equation tells us that where the cross-sectional area of a flowing fluid is

_________, the velocity is _____________ and conversely where the cross-sectional area is

__________________ the velocity is _______________.

Do Example 10-12

____

Section 9

Bernoulli's principle is derived from the continuity equation. State this principle in words:

Write Bernoulli's equation (10-5) below, defining all terms.

This equation is an expression of the ____.

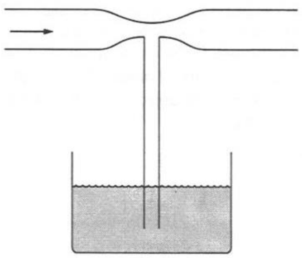
The term ½ ρv^2 can be thought of as being similar to what type of energy of a particle?

The term ρgy can be thought of as being similar to what type of energy of a particle?

Examine Figure 10-24 at the top of page 272. Write the derived version of Bernoulli's equation for this case, also known as Torricelli's theorem.

No process is required for these multiple choice questions. Put answers on lines provided.

38)____________



38. A T-shaped tube with a constriction is inserted in a vessel containing a liquid, as shown above. What happens if air is blown through the tube from the left, as shown by the arrow in the diagram?

(A) The liquid level in the tube rises to a level above the surface of the liquid surrounding the tube.
(B) The liquid level in the tube falls below the level of the surrounding liquid.
(C) The liquid level in the tube remains where it is.
(D) The air bubbles out at the bottom of the tube.
(E) Any of the above depending on how hard the air flows.

Questions 37-38

Helium gas is flowing steadily through the pipe shown above. The diameter of the pipe at the left end is 2.00×10^{-2} m and at the right is 1.00×10^{-2} m. The flow is slow enough that the density of the gas remains essentially constant. The volume flow rate is $2.00 \times 10^{-3}\ \mathrm{m^3/s}$.

37. The speed of the gas in the right end of the pipe is how many times the speed in the left end?

(A) 1/4
(B) 1/2
(C) 1
(D) 2
(E) 4

38. What is the speed of the gas in the left end of the pipe?

(A) 4×10^{-5} m/s
(B) 0.10 m/s
(C) 0.20 m/s
(D) $\frac{5}{\pi}$ m/s
(E) $\frac{20}{\pi}$ m/s

37) _______ 38)_______

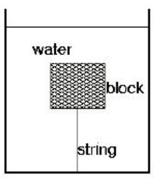
39. The pressure exerted on the bottom of a dam by the water in the reservoir created by the dam depends on the

(A) shape of the dam
(B) area of the dam
(C) depth of the water at the dam
(D) surface area of the reservoir
(E) shape of the bottom of the reservoir

40. A 3.0 kg block hanging from a spring scale is submerged in a beaker of water until the spring scale reads 20 N. What is the buoyant force on the block?

(A) 10 N
(B) 17 N
(C) 37 N
(D) 50 N
(E) It cannot be determined without knowing the dimensions of the block.

39)__________ 40)__________



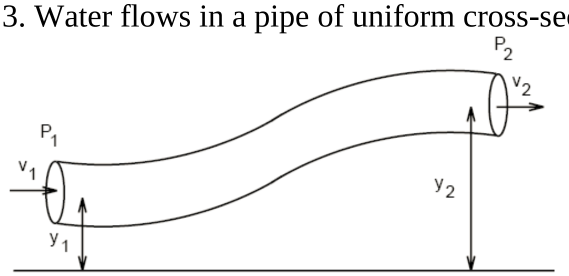
1. A block is connected to a light string attached to the bottom of a large container of water. The tension in the string is 3.0 N. The gravitational force from the earth on the block is 5.0 N. What is the block's volume? 1)__________

(A) $2.0\times10^{-4}\ m^3$ (B) $3.0\times10^{-4}\ m^3$ (C) $5.0\times10^{-4}\ m^3$ (D) $8.0\times10^{-4}\ m^3$ (E) $1.0\times10^{-3}\ m^3$

2. What vertical percentage of a 0.25 m deep sheet of ice, whose density is $0.95\text{x}10^3$ kg/m3, will be visible in an ocean whose density is $1.1\text{x}10^3$ kg/m

(a) 14% (b) 34% (c) 58% (d) 71% (e) 87% 2)_________

3. Water flows in a pipe of uniform cross-sectional area A.

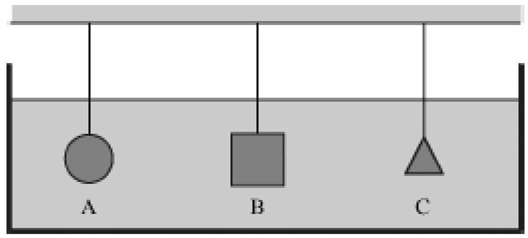


The pipe changes height from y_1 = 2 meters to y_2 = 3 meters. Since the areas are the same, we can say $v_1 = v_2$ Which of the following is true?

3)________

(a) $P_1 = P_2 + \rho g(y_2 - y_1)$ (b) $P_1=P_2$ c) $P_1 = 0$ d) $P_2 = 0$ e) $\rho_1>\rho_2$

1)



Three objects of identical mass attached to strings are suspended in a large tank of liquid, as shown above.

(a) Must all three strings have the same tension?

____ Yes ____ No

Justify your answer.

Object A has a volume of 1.0×10^{-5} m^3 and a density of 1300 kg/m^3. The tension in the string to which Object A is attached is 0.0098 N.

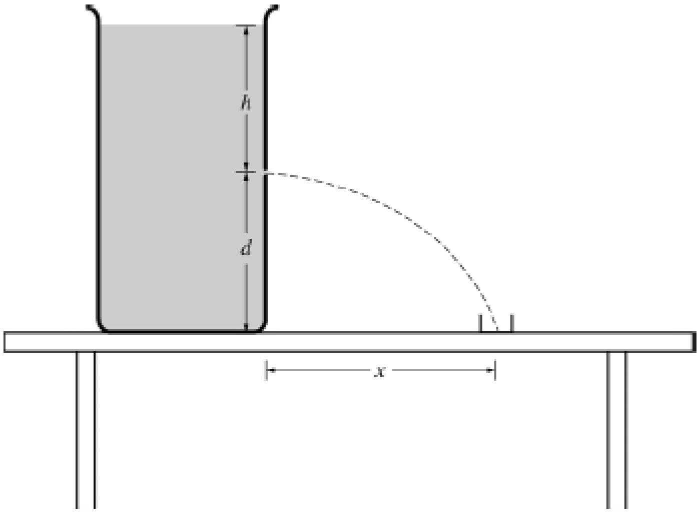
b) calculate the buoyant force on object A b) _________

c) Calculate the density of the liquid c)________

d) Some of the liquid is now drained from the tank until only half of the volume of object A is submerged. Would the tension in the string to which object A is attached increase, decrease or remain the same?

_______ Increase _________ Decrease ________ Remain the same

Justify your answer



2)

The large container shown in the cross section above is filled with a liquid of density $1.1 \times 10^3\ \text{kg/m}^3$. A small hole of area $2.5 \times 10^{-6}\ \text{m}^2$ is opened in the side of the container a distance h below the liquid surface, which allows a stream of liquid to flow through the hole and into a beaker placed to the right of the container. At the same time, liquid is also added to the container at an appropriate rate so that h remains constant. The amount of liquid collected in the beaker in 2.0 minutes is $7.2 \times 10^{-4}\ \text{m}^3$.

(a) Calculate the volume rate of flow of liquid from the hole in m^3/s.

a)________

b) calcúlate the speed of the liquid as it exits from the hole

b)________

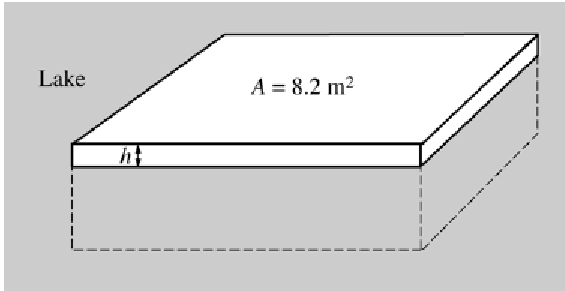
c) calculate the height h of liquid needed above the hole to cause the speed you determined in part b.

c)_________

d) suppose that there is now less liquid in the beaker so that the height h is reduced to h/2. In relation to the beaker, where will the liquid hit the tabletop.

_______ left of the beaker _______ in the beaker _______ right of the beaker

Justify your answer



Note: Figure not drawn to scale.

3)

A large rectangular raft (density 650 kg/m^3) is floating on a lake. The surface area of the top of the raft is 8.2 m^2 and its volume is 1.80 m^3. The density of the lake water is 1000 kg/m^3.

(a) Calculate the height h of the portion of the raft that is above the surrounding water.

a)______________

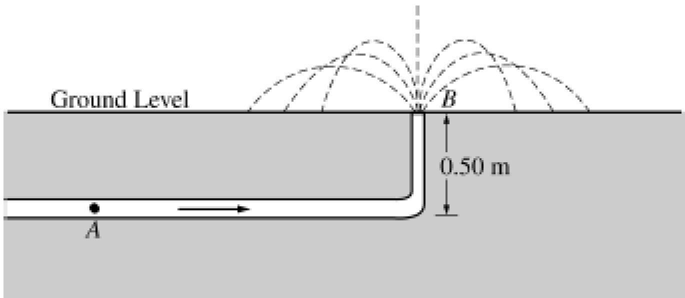
b) calculate the magnitude of the buoyant force on the raft and state its direction

b)________________

____

c) If the average mass of a person is 75 kg, calculate the maximum number of people that can be on the raft without the top of the raft sinking below the surface of the water. (assume that the people are evenly distributed on the raft).

c)_______________



4)

An underground pipe carries water of density $1000\ \text{kg}/\text{m}^3$ to a fountain at ground level, as shown above. At point *A*, 0.50 m below ground level, the pipe has a cross-sectional area of $1.0 \times 10^{-4}\ \text{m}^2$. At ground level, the pipe has a cross-sectional area of $0.50 \times 10^{-4}\ \text{m}^2$. The water leaves the pipe at point *B* at a speed of 8.2 m/s.

(a) Calculate the speed of the water in the pipe at point *A*.

a)____________

b) calculate the absolute water pressure in the pipe at point A

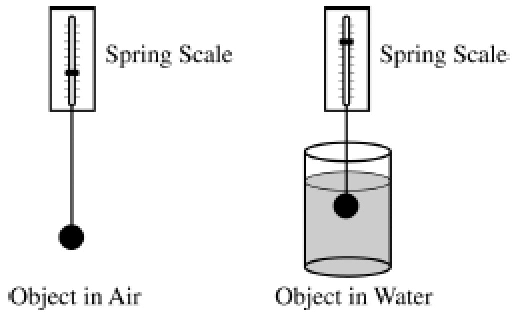
b)____________

c) calculate the maximum height above the ground that the water reaches upon leaving the pipe vertically at ground level, assuming air resistance is negligible.

c)____________

d) calculate the horizontal distance from the pipe that is reached by water exiting the pipe at 60^o from the level ground, assuming air resistance is negligible.

d)__________



5)

An object is suspended from a spring scale first in air, then in water, as shown in the figure above. The spring scale reading in air is 17.8 N, and the spring scale reading when the object is completely submerged in water is 16.2 N. The density of water is 1000 kg/m^3.

(a) Calculate the buoyant force on the object when it is in the water.

a)____________

b) calculate the volume of the object

b)____________

c) calculate the density of the object c)______________

d) How would the absolute pressure at the bottom of the water change if the object was removed?

______ It would increase ________ It would decrease ______ It would remain the same

Justify your answer.