Hydrostatics Practice

Level 1: Introduction to Fluids

Multiple Choice Practice

1. Which of the following could be a correct unit for pressure?

$(A)\ \frac{kg}{m^2}$ $(B)\ \frac{kg}{m \cdot s}$ $(C)\ \frac{kg}{s^2}$ $(D)\ \frac{kg}{m \cdot s^2}$ $(E)\ \frac{m \cdot s}{kg}$

2. The mass of a 1.3 m^3 object with a specific gravity of 0.82 is
(a) 630 kg (b) 730 kg (c) 820 kg (d) 1100 kg (e) 1600 kg

3. A vertical force of 30 N is applied uniformly to a flat button with a radius of 1 cm that is lying on a table. Which of the following is the best order of magnitude estimate for the pressure applied to the button?
(A) 10 Pa
(B) 10^2 Pa
(C) 10^3 Pa
(D) 10^4 Pa
(E) 10^5 Pa

4. A frog is at rest at the bottom of a lake at a depth y below the surface. If the top surface of the frog has area A, which of the following expressions correctly describes the total downward force F exerted on the frog?
(A) $(P_0 + \rho g y)\, A$
(B) $P_0 A$
(C) $\rho g y A$
(D) $(P_0 + \frac{1}{2}\rho v^2)\, A$
(E) $P_0 + \rho g y$

5. Using the value of atmospheric pressure at sea level, 1.0×10^5 Pa, what is the approximate mass of Earth's atmosphere that is above a flat building that has a rooftop area of 5.0 m^2?
(A) 2.0×10^{-4} kg
(B) 4.0×10^{-2} kg
(C) 9.0×10^{2} kg
(D) 5.0×10^{4} kg
(E) 5.0×10^{5} kg

6.

If the gauge pressure of a device reads 2.026×10^5 N/m^2, the absolute pressure it is measuring is
(a) 1.013×10^5 N/m^2
(b) 2.052×10^5 N/m^2
(c) 2.026×10^5 N/m^2
(d) 3.039×10^5 N/m^2
(e) 6.078×10^5 N/m^2

Free Response

Example 18.7 **A flat piece of wood, of area 0.5 m², is lying at the bottom of a lake. If the depth of the lake is 30 m, what is the force on the wood due to the pressure? (Use $p_{atm} = 1 \times 10^5$ Pa.)**

Example 18.8 Consider a closed container, partially filled with a liquid of density $\rho = 1200$ kg/m^3, and a point X that's 0.5 m below the surface of the liquid.

(a) If the space above the surface of the liquid is vacuum, what's the absolute pressure at point X?

(b) If the space above the surface of the liquid is occupied by a gas whose pressure is 2.4×10^4 Pa, what's the absolute pressure at point X?

Free Response Question 2

2003B6.

A diver descends from a salvage ship to the ocean floor at a depth of 35 m below the surface. The density of ocean water is 1.025×10^3 kg/m^3.

(a) Calculate the gauge pressure on the diver on the ocean floor.

(b) Calculate the absolute pressure on the diver on the ocean floor.

The diver finds a rectangular aluminum plate having dimensions 1.0 m x 2.0 m x 0.03 m. A hoisting cable is lowered from the ship and the diver connects it to the plate. The density of aluminum is 2.7×10^3 kg/m^3. Ignore the effects of viscosity.

(c) Calculate the tension in the cable if it lifts the plate upward at a slow, constant velocity.

(d) Will the tension in the hoisting cable increase, decrease, or remain the same if the plate accelerates upward at 0.05 m/s^2?

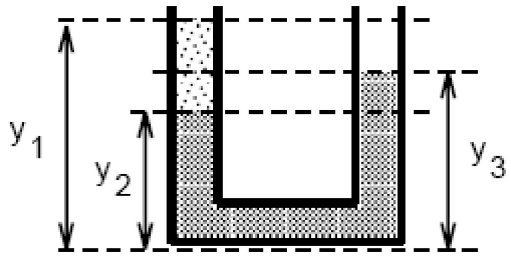
____ increase ____ decrease ____ remain the same

Explain your reasoning.

Level 2: Measuring Pressure

Multiple Choice

1.



In the open manometer shown, water occupies a part of the left arm, from a height of y_1 to a height of y_2. The remainder of the left arm, the bottom of the tube, and the right arm to a height of y_3 are filled with mercury.

Which of the following is correct?
(a) the pressure at a height y_3 is the same in both arms.
(b) the pressure at a height y_2 is the same in both arms.
(c) the pressure at the bottom of the right arm is greater than at the bottom of the left arm.
(d) the pressure at a height y_3 is less in the left arm than in the right arm.
(e) the pressure at a height y_1 is greater in the left arm than in the right arm.

Level 3: Pascal's Principle

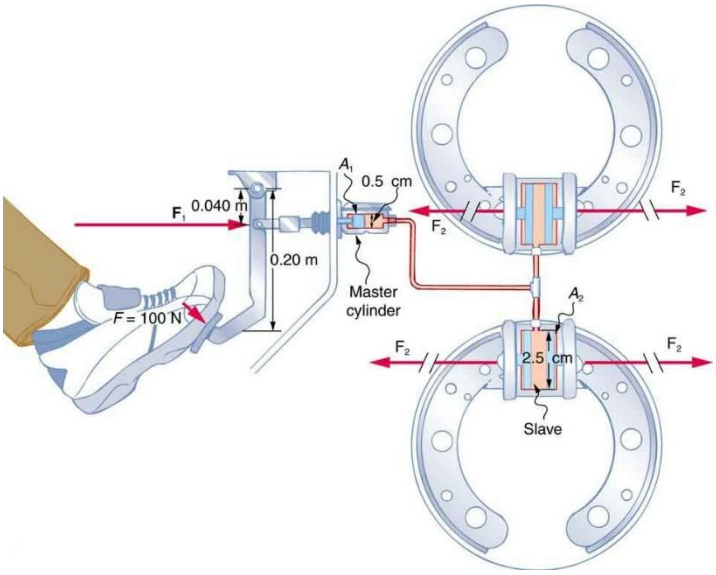
Multiple Choice Practice

1. A 500 N weight sits on the small piston of a hydraulic machine. The small piston has an area of 2 cm^2. If the large piston has an area of 40 cm^2, how much weight can the large piston support?
   A) 25 N
   B) 500 N
   C) 10000 N
   D) 40000 N
2. A 500 N weight sits on the small piston of a hydraulic machine. The small piston has an area of 2 cm^2 . If the large piston has an area of 40 cm2, how much weight can the large piston support?

   A) 25 N
   B) 500 N
   C) 10000 N
   D) 40000 N

Free Response

A force of 100 N is applied to the brake pedal, which acts on the cylinder—called the master—through a lever. A force of 500 N is exerted on the master cylinder. (The reader can verify that the force is 500 N using techniques of statics from Applications of Statics, Including Problem-Solving Strategies.) Pressure created in the master cylinder is transmitted to four so-called slave cylinders. The master cylinder has a diameter of 0.500 cm, and each slave cylinder has a diameter of 2.50 cm. Calculate the force F_2 created at each of the slave cylinders.



Level 4: Buoyancy

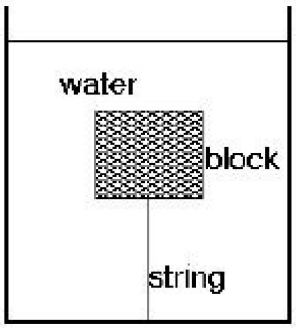
1.

A block of mass m, density ρ_B , and volume V is completely submerged in a liquid of density ρ_L. The density of the block is greater than the density of the liquid. The block
(a) floats, because $\rho_B > \rho_L$
(b) experiences a buoyant force equal to ρ_B gV.
(c) experiences a buoyant force equal to ρ_L gV.
(d) experiences a buoyant force equal to m_B g
(e) does not experience any buoyant force, because $\rho_B > \rho_L$.

2. 50 cm^3 of wood is floating on water, and 50 cm^3 of iron is totally submerged. Which has the greater buoyant force on it?
   A) The wood.
   B) The iron.
   C) Both have the same buoyant force.
   D) Cannot be determined without knowing their densities.

3. A cork has weight mg and density 25% of water density. A string is tied around the cork and attached to the bottom of a water-filled container. The cork is totally immersed. Express in terms of the cork weight mg, the tension in the string
   A) 0
   B) mg
   C) 2mg
   D) 3mg
   E) 4mg

4.



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?

(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) $1.0\times10^{-3}\ m^3$

5. Three fishing bobbers all float on top of water. They have the following relationships:
   -A,B: same mass, same density, different shapes
   -B,C: same size, same shape, mass & density
   C < mass & density B
   Three identical weights are tied to each bob, and each is pulled completely beneath the water. Which bob will displace the greatest amount of water
   A) A
   B) B
   C) C
   D) A and B
   E) All displace the same amount of water.
6. Salt water is more dense than fresh water. A ship floats in both fresh water and salt water. Compared to the fresh water, the amount of water displaced in the salt water is
   A) more.
   B) less.
   C) the same.
   D) Cannot be determined from the information given.

Free Response

2005B5.

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 and its volume is 1.80 m^2. 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.

(b) Calculate the magnitude of the buoyant force on the raft and state its direction.

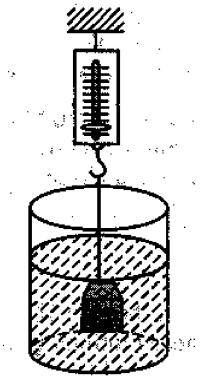
(c) If the average mass of a person is 75 kg, calculate the maximum number of people that can be on the raft without the top of the raft sinking below the surface of the water. (Assume that the people are evenly

distributed on the raft.)

Level 5: Percent Submerged and Apparent Weight

Multiple Choice

1. What vertical percentage of a 0.25 m deep sheet of ice, whose density is 0.95×10^3 kg/m^3, will be visible in an ocean whose density is 1.1×10^3 kg/m
   (a) 14% (b) 34% (c) 58% (d) 71% (e) 87%

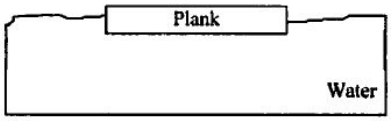


2. The figure shows an object of mass 0.4 kg that is suspended from a scale and submerged in a liquid. If the reading on the scale is 3 N, then the buoyant force that the fluid exerts on the object is most nearly
   (A) 1.3 N
   (B) 1.0N
   (C) 0.75 N
   (D) 0.33 N
   (E) 0.25 N

Free Response

Practice Problem 1

SAMPLE PROBLEM 2



A plank of pine wood (density of 550 kg/m^3) of dimensions 4.0 m × 4.0 m × 0.3 m is placed in a water bath whose density is 1000 kg/m^3 as shown.

(a) Sketch the forces acting on the floating plank.
(b) Verify by calculation that this plank must float.
(c) Determine the buoyant force on this plank while it is floating.
(d) Determine the percentage of the plank that is not submerged.

Problem 2

2003B6.
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Explain your reasoning.

Problem 3

Example 18.10 A brick, of specific gravity 2 and volume 1.5×10^{-3} m^3, is dropped into a swimming pool full of water.

(a) Explain briefly why the brick will sink.

(b) When the brick is lying on the bottom of the pool, what is the magnitude of the normal force on the brick?