Fluids Practice Problems

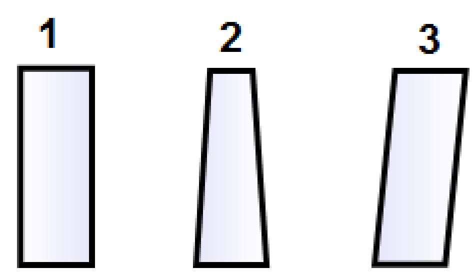
PSI AP Physics B Name________________________________

Multiple Choice Questions

1. Two substances mercury with a density 13600 kg/m^3 and alcohol with a density 0.8 kg/m^3 are selected for an experiment. If the experiment requires equal masses of each liquid, what is the ratio of alcohol volume to the mercury volume?
(A) 1/15 (B) 1/17 (C) 1/13 (D) 1/10 (E) 17/1

2. A perpendicular force is applied to a certain area and produces a pressure P. If the same force is applied to a twice bigger area, the new pressure on the surface is:
(A) 2P (B) 4P (C) P (D) P/2 (E) P/4

3. There are two round tables in the physics classroom: one with the radius of 50 cm the other with a radius of 150 cm. What is the relationship between the two forces applied on the tabletops by the atmospheric pressure?
(A) $F_1/F_2 = 1/3$ (B) $F_1/F_2 = 1/9$ (C) $F_1/F_2 = 3/1$ (D) $F_1/F_2 = 9/1$ (E) $F_1/F_2 = 1/6$



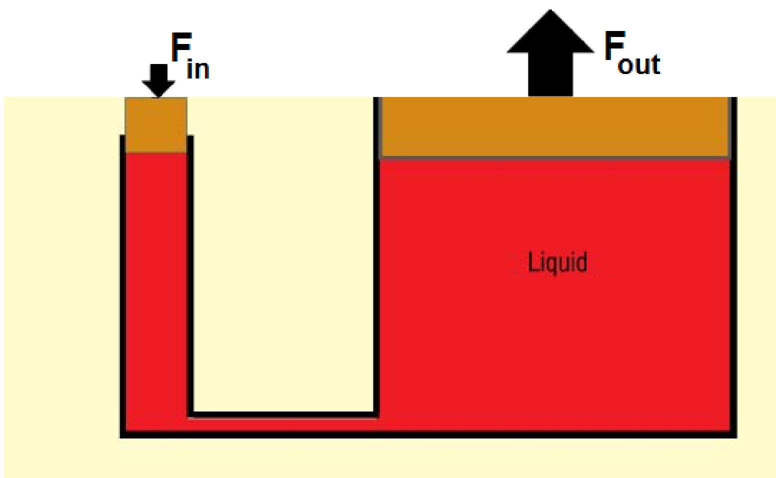
4. Three containers are used in a chemistry lab. All containers have the same bottom area and the same height. A chemistry student fills each of the containers with the same liquid to the maximum volume. Which of the following is true about the pressure on the bottom in each container?
(A) $P_1 > P_2 > P_3$
(B) $P_1 < P_2 < P_3$
(C) $P_1 < P_2 > P_3$
(D) $P_1 > P_2 < P_3$
(E) $P_1 = P_2 = P_3$

5. What is the difference between the pressure on the bottom of a pool and the pressure on the water surface?
(A) ρgh (B) ρg/h (C) ρ/gh (D) gh/ ρ (E) zero

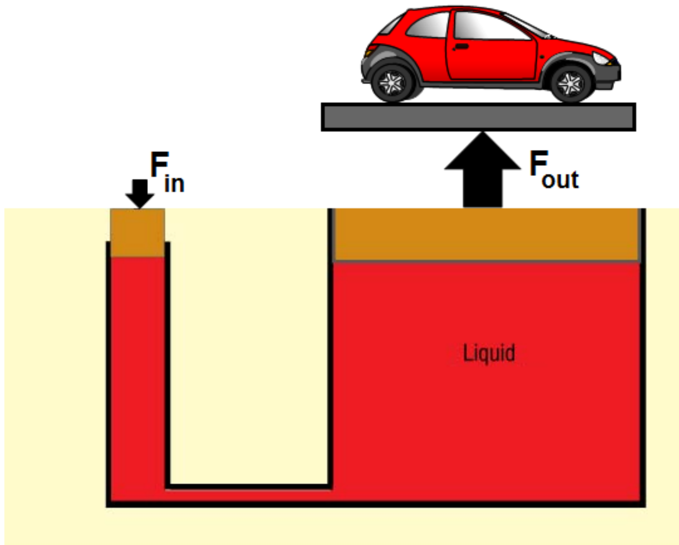
6. A boy swims a lake and initially dives 0.5 m beneath the surface. When he dives 1 m beneath the surface, how does the absolute pressure change?
   (A) It doubles
   (B) It quadruples
   (C) It cut to a half
   (D) It slightly increases
   (E) It slightly decreases

7. Which of the following scientists invented a mercury barometer?
   (A) Blaise Pascal
   (B) Evangelist Torricelli
   (C)Amedeo Avogadro
   (D)Robert Brown
   (E) James Joule

8. A car driver measures a tire pressure of 220 kPa. What is the absolute pressure in the tire?
   (A) 321 kPa (B) 119 kPa (C) 0 kPa (D) 101 kPa (E) 220 kPa



9. In a hydraulic lift the small piston has an area of 2 cm^2 and large piston has an area of 80 cm^2. What is the mechanical advantage of the hydraulic lift?
   (A) 40 (B) 4 (C) 2 (D) 1 (E) 20



10. A hydraulic lift is used to lift a car. The small piston has a radius of 5 cm and the large piston has a radius of 50 cm. If a driver applies a force of 88 N to the small piston, what is the weight of the car the large piston can support?

(A) 880 N (B) 88 N (C) 8800 N (D) 8.8 N (E) 88000 N

11. Three blocks of equal volume are completely submerged into water. The blocks made of different materials: aluminum, iron and lead. Which of the following is the correct statement about the buoyant force on each block? ($P_{aluminum}$ = 2700 kg/m^3, ρ_{iron} = 7800 kg/m^3, ρ_{lead} = 11300 kg/m^3)

(A) $F_{aluminum} > F_{iron} > F_{lead}$

(B) $F_{aluminum} < F_{iron} < F_{lead}$

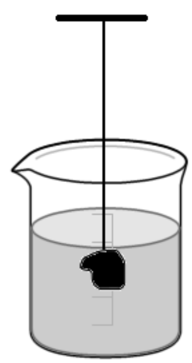
(C) $F_{aluminum} < F_{iron} > F_{lead}$

(D) $F_{aluminum} = F_{iron} = F_{lead}$

(E) $F_{aluminum} > F_{iron} < F_{lead}$

12. A piece of iron has a weight of 3.5 N when it is in air and 2.0 N when it is submerged into water. What is the buoyant force on the piece of iron?
    (A) 3.5 N (B) 2.0 N (C) 1.5 N (D) 1.0 N (E) 0.5 N

13. Physics students use a spring scale to measure the weight of a piece of lead. The experiment was performed two times one in air the other in water. If the volume of lead is 50 cm^3, what is the difference between two readings on the scale?
    (A) 0.5 N (B) 5.0 N (C) 50 N (D) 500 N (E) 0 N



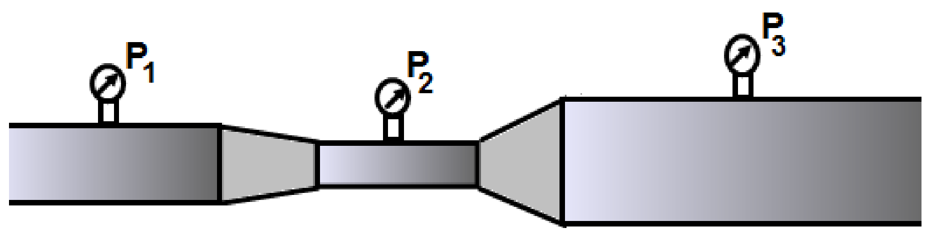
14. A solid cylinder of mass 5 kg is completely submerged into water. What is the tension force in the string supporting the piece of aluminum if the specific gravity of the cylinder's material is 10?
    (A) 5 N (B) 0.5 N (C) 50 N (D) 45 N (E) 10 N

15. An object has a weight of 9 N when it is in air and 7.2 N when it is submerged into water. What is the specific gravity of the object's material?
(A) 5 (B) 6 (C) 7 (D) 8 (E) 9

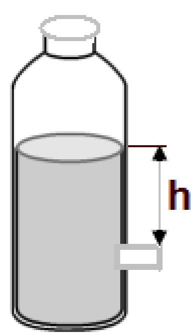
16. A wooden block with a weight of 7.5 N is placed on water. When the block floats on the surface of water it is partially submerged in water. What is the weight of the displaced water?
(A) 5.0 N (B) 5.5 N (C) 6.0 N (D) 7.0 N (E) 7.5 N

17. A wooden block with a weight of 9 N is placed on water. When the block floats on the surface of water it is partially submerged in water. What is the volume of the displaced water?
(A) 500 cm^3 (B) 400 cm^3 (C) 300 cm^3 (D) 600 cm^3 (E) 900 cm^3

18. Water flows at a constant speed of 16 m/s through narrow section of the pipe. What is the speed of water in the section of the pipe where its radius is twice of the initial radius?
(A) 16 m/s (B) 12 m/s (C) 8 m/s (D) 4 m/s (E) 2 m/s

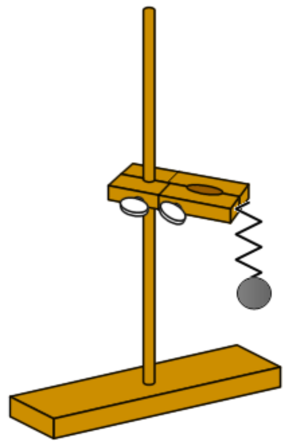


19. Venturi tubes have three sections with different radii. Which of the following is true about manometer readings?
(A) $P_1 > P_2 > P_3$
(B) $P_1 < P_2 < P_3$
(C) $P_2 < P_1 < P_3$
(D) $P_1 < P_2 > P_3$
(E) $P_3 = P_2 = P_1$

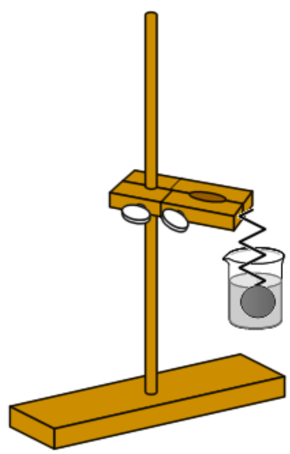


20. An open bottle is filled with a liquid which is flowing out trough a spigot located at the distance h below the surface of the liquid. What is the velocity of the liquid leaving the bottle?
(A) v = $\sqrt{gh}$ (B) 2gh (C) 4gh (D) ρgh (E) $\sqrt{2gh}$

Free Response Problems



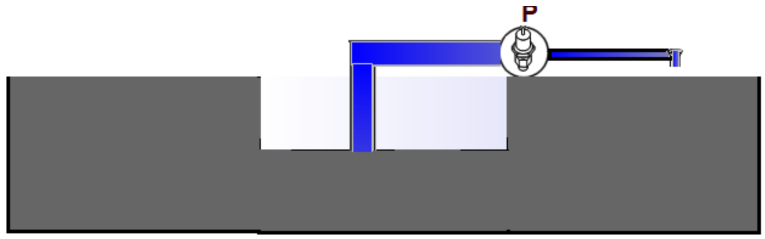
1. A small sphere of mass m and density D is suspended from an elastic spring. The spring is stretched by a distance X_1.
    a. Determine the spring constant.



The sphere is submerged into liquid of unknown density $\rho < D$. The new displacement of the spring is X_2.

b. On the diagram below show all the applied forces on the sphere when it is submerged.

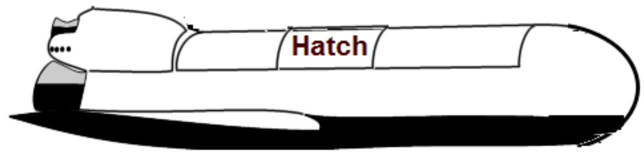
c. Determine the weight of the displaced liquid by the sphere.
d. Determine the density of liquid. Express your result in terms of D, X_1, X_2.



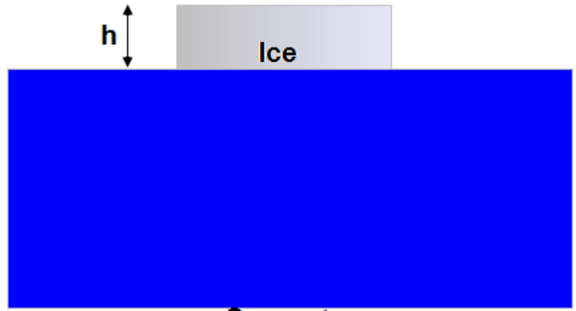
2. A pool has an area $A = 50\ m^2$ and depth $h = 2.5$ m. The pool is filled with water to the maximum height. An electrical pump is used to empty the pool. There are two pipes coming out the pump: one is submerged into water has a radius $r_1 = 4$ cm the other has a radius $r_2 = 2.5$ cm. Answer the following questions ignoring friction, viscosity, turbulence.
   a. Calculate the net force on the bottom of the pool.
   b. Calculate work done by the pump required to empty the pool in 5 h.
   c. Calculate the speed of the water flow in the submerged pipe.

The pump produces a pressure $P_1 = 9*10^5$ Pa in the submerged pipe.

   d. Calculate speed of the water flow in the second section of the pipe placed on the ground.



3. A submarine dives from rest a 100-m distance beneath the surface of an ocean. Initially the submarine moves at a constant rate 0.3 m/s^2 until reaches a speed of 4 m/s and then lowers at a constant speed. The density of salt water is 1030 kg/m^3. The submarine has a hatch with an area of 2 m^2 located on the top of the submarine's body.
    a. How much time it takes for the submarine to move down 100 m?
    b. Calculate the gauge pressure applied on the submarine at the depth of 100 m.
    c. Calculate the absolute pressure applied on the submarine at the depth of 100.
    d. How much force is required in order to open the hatch from the inside of submarine?

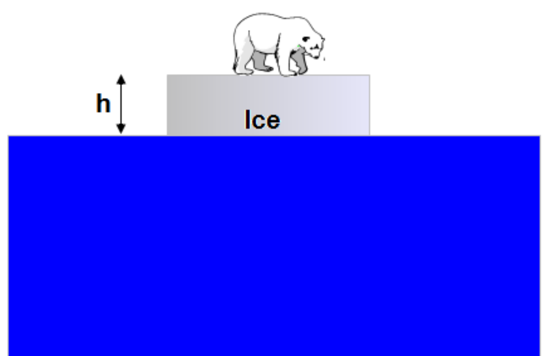


4. A rectangular slab of ice floats on water with a large portion submerged beneath the water surface. The volume of the slab is 20 m^3 and the surface area of the top is 14 m2. The density of ice is 900 kg/m^3 and sea water is 1030 kg/m^3.
   a. On the diagram below show all the applied forces on the slab.

   b. Calculate the buoyant force on the slab.
   c. Calculate the height h of the portion of the slab that is above the water surface.

A polar bear climbs to the top of the slab and sits on the slab for a long time.

   d. On the diagram below show all the applied forces on the slab.



   e. If the average mass of a polar bear is 500 kg, calculate the maximum number of bears that can sit on the slab without sinking.

Answers

1. E
2. D
3. B
4. E
5. A
6. D
7. B
8. A
9. A
10. C
11. D
12. C
13. A
14. D
15. A
16. E
17. E
18. D
19. C
20. E

1. a) mg/x_1
   b) Buoyant force and Force of the spring up and mg down
   c) $mg(1-x_2/x_1)$
   d) $D(1-x_2/x_1)$

2. a) $6.3x10^6N$
   b) $3.1x10^6J$
   c) 1.38 m/s
   d) 39.4 m/s

3. a) 31.7s
   b) $1.03x10^6N/m^2$
   c) $1.13x10^6N/m^2$
   d)$2.06x10^6N/m^2$

4. a)Buoyant Force up and mg down
   b) $1.8x10^5N$
   c) 0.15m
   d) Buoyant Force up, $m_{ice}g$ and $m_{bear}g$ down
   e) 5 bears