

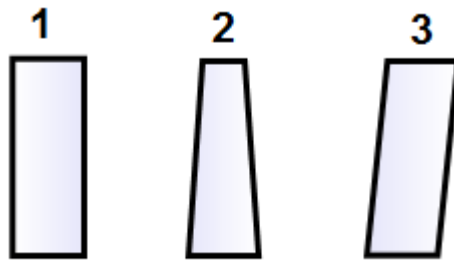
Fluids Practice Problems

PSI AP Physics B

Name _____

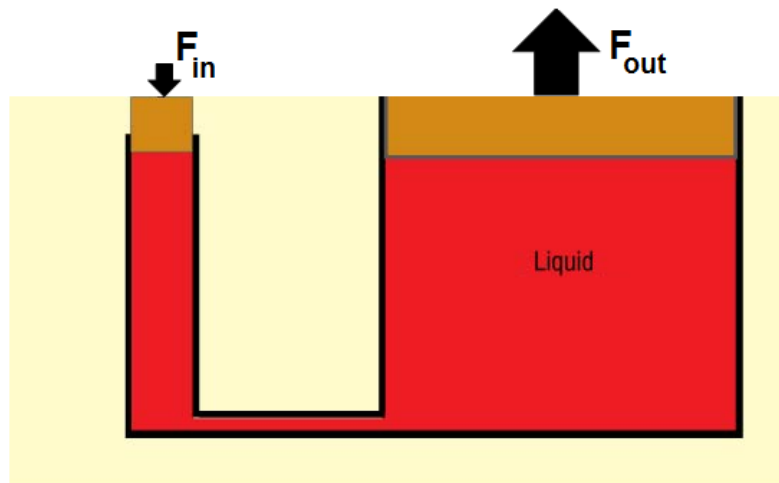
Multiple Choice Questions

- Two substances mercury with a density 13600 kg/m^3 and alcohol with a density 800 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) $17/1$
- A perpendicular force F is applied to a certain area A and produces a pressure P . If the same force is applied to an area two times in size, the new pressure on the surface is:
(A) $2P$ (B) $4P$ (C) P (D) $P/2$
- 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) $F_1/F_2 = 9/1$

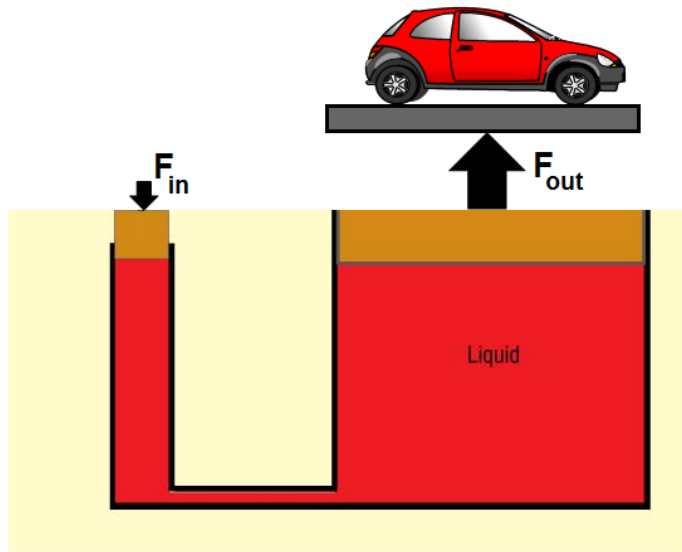


- Three containers are used in a chemistry lab. All containers have the same bottom area and the same height. A chemistry student fills each of the containers with the same liquid to the maximum volume. Which of the following is true about the pressure on the bottom in each container?
(A) $P_1 > P_2 > P_3$
(B) $P_1 < P_2 < P_3$
(C) $P_1 < P_2 > P_3$
(D) $P_1 = P_2 = P_3$
- What is the difference between the pressure on the bottom of a pool and the pressure on the water surface?
(A) ρgh (B) $\rho g/h$ (C) ρ/gh (D) gh/ρ

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



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



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

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? ($\rho_{\text{aluminum}} = 2700 \text{ kg/m}^3$, $\rho_{\text{iron}} = 7800 \text{ kg/m}^3$, $\rho_{\text{lead}} = 11300 \text{ kg/m}^3$)

- (A) $F_{\text{aluminum}} > F_{\text{iron}} > F_{\text{lead}}$
 (B) $F_{\text{aluminum}} < F_{\text{iron}} < F_{\text{lead}}$
 (C) $F_{\text{aluminum}} < F_{\text{iron}} > F_{\text{lead}}$
 (D) $F_{\text{aluminum}} = F_{\text{iron}} = F_{\text{lead}}$

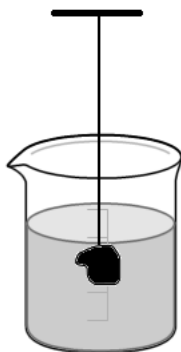


12. A piece of iron has a weight of 3.5 N when it is in air and 2.0 N when it is submerged into water. What is the buoyant force on the piece of iron?

- (A) 3.5 N (B) 2.0 N (C) 1.5 N (D) 1.0 N

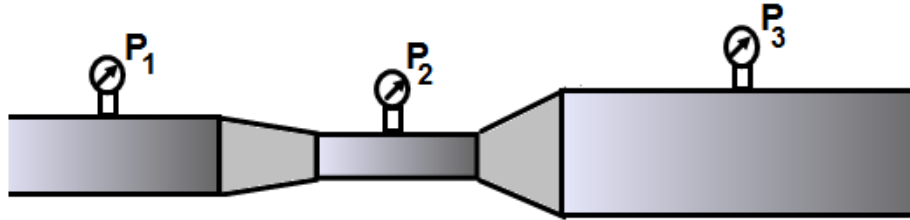


13. Physics students use a spring scale to measure the weight of a piece of lead. The experiment was performed two times: once in the air and once in water. If the volume of lead is 50 cm^3 , what is the difference between the two readings on the scale?
- (A) 0.5 N (B) 5.0 N (C) 50 N (D) 500 N

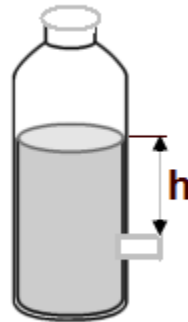


14. A solid cylinder of mass 5 kg is completely submerged into water. What is the tension force in the string supporting the piece of aluminum if the specific gravity of the cylinder's material is 10?
- (A) 5 N (B) 0.5 N (C) 50 N (D) 45 N
15. An object has a weight of 9 N when it is in air and 7.2 N when it is submerged into water. What is the specific gravity of the object's material?
- (A) 5 (B) 6 (C) 7 (D) 8
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) 7.5 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) 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



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) $P_3 = P_2 = P_1$



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

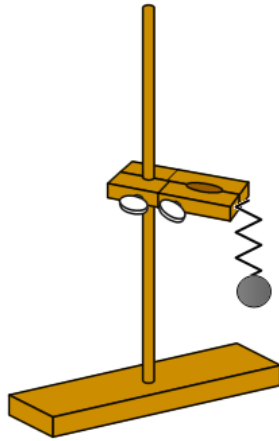
21. A table surface of area A is placed underwater in a tank at a depth H relative to the surface of the water. A toy submarine is placed into the water and it sinks onto the table. If the submarine has a mass that cannot be ignored, and the amount of water displaced from the tank is M_w , what is the pressure on the table surface?

- (A) $\frac{g(\rho H - M_w)}{A}$
 (B) $\frac{g(\rho H + M_w)}{A}$
 (C) $\frac{g[\rho H - (M_s + M_w)]}{A}$
 (D) $\frac{g[\rho H + (M_s - M_w)]}{A}$

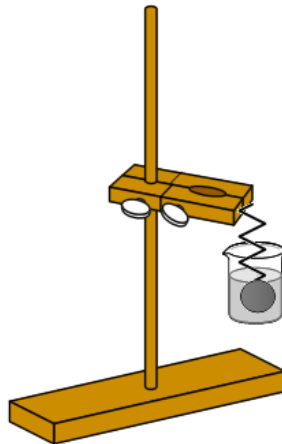
Multi-correct Section: For each question or incomplete statement, two of the answers are correct. For each questions you must select both answers.

22. A student wishes to test which things will float on olive oil. Olive oil has a specific gravity of 0.70. The following are specific gravities of various substances. Which will float on olive oil? Select two answers.
- (A) Oak - 0.78
 - (B) Balsa wood - 0.16
 - (C) Beeswax – 0.95
 - (D) Charcoal – 0.40
23. Two boxes lie on a table top: a 2 N box with a volume of $5 \times 6 \times 4 \text{ cm}^3$ and a 3 N box with a volume of $4 \times 5 \times 9 \text{ cm}^3$. Which two arrangements will exert the same pressure? Select two answers.
- (A) The 2N box on the 6 cm x 5 cm side.
 - (B) The 2N box on the 4 cm x 5 cm side.
 - (C) The 3N box on the 4 cm x 5 cm side.
 - (D) The 3N box on the 5 cm x 9 cm side.
24. A partially evacuated vertical cylindrical container is covered by a circular lid that makes an airtight seal. The pressure in the room is $1.01 \times 10^5 \text{ Pa}$ and the pressure inside the container is $0.41 \times 10^5 \text{ Pa}$. What other two quantities would you need to know in order to calculate the minimum upward applied force required to lift the lid? Select two answers.
- (A) The volume of the container.
 - (B) The density of the air in the container.
 - (C) The mass of the lid.
 - (D) The radius of the lid.
25. Four objects are thrown into water. Two objects, with volumes 0.02m^3 and 0.04m^3 , float and two objects, also with volumes 0.02m^3 and 0.04m^3 , sink. Which two objects could have the same buoyant force exerted on them? Select two answers.
- (A) The object with a volume of 0.02m^3 that floats.
 - (B) The object with a volume of 0.04m^3 that floats.
 - (C) The object with a volume of 0.02m^3 that sinks.
 - (D) The object with a volume of 0.04m^3 that sinks.

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.

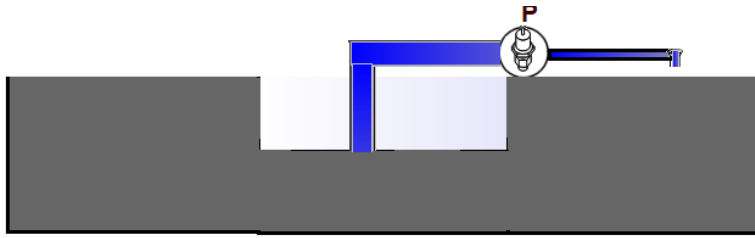


The sphere is submerged into liquid of unknown density $\rho < D$. The new displacement of the spring is X_2 .

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



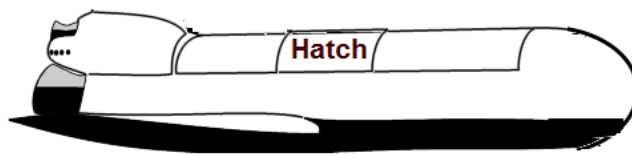
- c. Determine the weight of the displaced liquid by the sphere.
 - d. Determine the density of liquid. Express your result in terms of D , X_1 , X_2 .



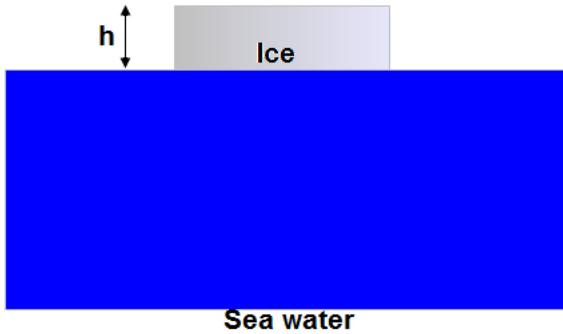
2. A pool has an area $A = 50 \text{ m}^2$ and depth $h = 2.5 \text{ m}$. The pool is filled with water to the maximum height. An electrical pump is used to empty the pool. There are two pipes coming out the pump: one is submerged into water and has a radius $r_1 = 4 \text{ cm}$ while the other has a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

The pump produces a pressure $P_1 = 9 \cdot 10^5 \text{ Pa}$ in the submerged pipe.

- 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 the Pacific Ocean. Initially the submarine accelerates down at a constant rate 0.3 m/s^2 until it reaches a speed of 4 m/s and then continues its journey down 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.
- How much time it takes for the submarine to move down 100 m?
 - Calculate the gauge pressure applied on the submarine at the depth of 100 m.
 - Calculate the absolute pressure applied on the submarine at the depth of 100.
 - How much force is required in order to open the hatch from the inside of submarine?



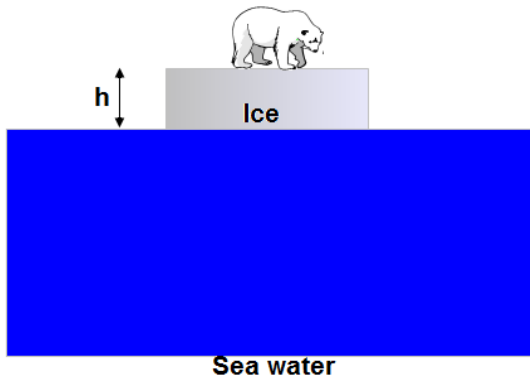
4. A rectangular slab of ice floats on water with a large portion submerged beneath the water surface. The volume of the slab is 20 m^3 and the surface area of the top is 14 m^2 . The density of ice is 900 kg/m^3 and sea water is 1030 kg/m^3 .
- On the diagram below show all the applied forces on the slab.



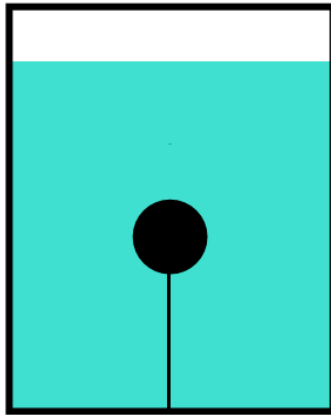
- Calculate the buoyant force on the slab.
- Calculate the height h of the portion of the slab that is above the water surface.

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

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



- 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.



5. A sphere with a radius of 5 cm is completely submerged in a tank of water and it is attached to the bottom of the tank by a string as shown in the picture above. The tension in the string is 0.75 times the weight of the sphere. The density of water is 1000 kg/m^3 .
- The circle below represents the sphere. Draw and label each of the applied forces that act on the sphere.

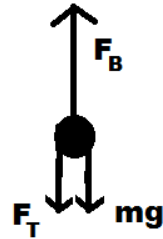


- Calculate the density of the sphere.
- The string is cut and the sphere begins to move. Calculate the initial acceleration of the sphere immediately after the string is cut.
- Does the buoyant force change as the sphere rises to the surface? Justify your answer.
- Does the buoyant force change as the sphere reaches the surface and rises out of the water? Justify your answer.

Answers

- | | | |
|------|-------|----------|
| 1. D | 10. C | 19. C |
| 2. D | 11. D | 20. A |
| 3. B | 12. C | 21. D |
| 4. D | 13. A | 22. B, D |
| 5. A | 14. D | 23. A, D |
| 6. D | 15. A | 24. C, D |
| 7. B | 16. D | 25. B,C |
| 8. A | 17. D | |
| 9. A | 18. D | |

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) $6.3 \times 10^6 \text{ N}$
 b) $3.1 \times 10^6 \text{ J}$
 c) 1.38 m/s
 d) 39.4 m/s
3. a) 31.7 s
 b) $1.03 \times 10^6 \text{ N/m}^2$
 c) $1.13 \times 10^6 \text{ N/m}^2$
 d) $2.06 \times 10^6 \text{ N/m}^2$
4. a) Buoyant Force up and mg down
 b) $1.8 \times 10^5 \text{ N}$
 c) 0.15 m
 d) Buoyant Force up, $m_{\text{ice}}g$ and $m_{\text{bear}}g$ down
 e) 5 bears



5. a)
 b) 571 kg/m^3
 c) 7.4 m/s^2
 d) The buoyant force will stay the same since it depends only on the volume of fluid displaced and the density of the fluid.
 e) The buoyant force will change since the sphere will not be fully submerged therefore the volume of fluid displaced will decrease and so the buoyant force will decrease.