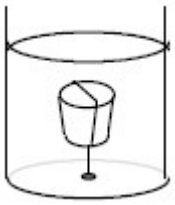
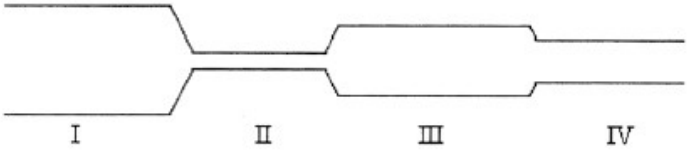
AP Physics Multiple Choice Practice – Fluid Mechanics

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



2. An ideal fluid flows through a long horizontal circular pipe. In one region of the pipe, it has radius R. The pipe then widens to radius 2R. What is the ratio of the fluid's speed in the region of radius R to the speed of the fluid in region with radius 2R?
   A) 4 B) 2 C) ½ D) ¼

3. A fluid is forced through a pipe of changing cross section as shown. In which section would the pressure of the fluid be a minimum?



   A) I B) II C) III D) IV

4. Three objects all float on top of water. They have the following relationships:
   - A and B have the same mass and same density but different shapes
   - B and C have the same volume and same shape
   - mass & density of C < mass & density of B

   Three identical weights are tied to each object, and each is pulled completely beneath the water. Which object will displace the greatest amount of water?
   A) A
   B) B
   C) C
   D) All displace the same amount of water.

5. As a rock sinks deeper and deeper into water of constant density, what happens to the buoyant force on it?
   A) It increases.
   B) It remains constant.
   C) It decreases.
   D) It may increase or decrease, depending on the shape of the rock.

6. A piece of wood with a volume of 50 cm^3 is floating on water, and a piece of iron with a volume of 50 cm^3 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.

7. 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 by the ship when it i in the salt water is
   A) more.
   B) less.
   C) the same.
   D) Cannot be determined from the information given.

8. Water flows through a horizontal pipe. The diameter of the pipe at point B is larger than at point A. Where is the water pressure greater?
   A) Point A
   B) Point B
   C) Same at both A and B
   D) Cannot be determined from the information given.

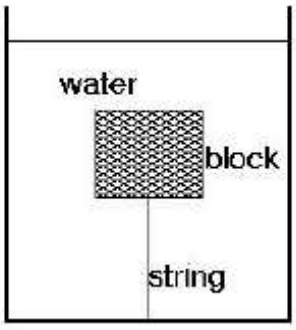
9. Liquid flows through a 4 cm diameter pipe at 1.0 m/s. There is a 2 cm diameter constriction in the line. What is the velocity in this constriction?
   A) 0.25 m/s B) 0.50 m/s C) 2 m/s D) 4 m/s

10. A copper block is connected to a string and submerged in a container of water.
    Position 1: The copper is completely submerged, but just under the surface of the water.
    Position 2: The copper is completely submerged, mid-way between the water surface and the bottom of the container.
    Position 3: The copper is completely submerged, but just above the bottom surface of the container.

    Assume that the water is incompressible. What is the ranking of the buoyant forces (B) acting on the copper blocks for these positions, from least to greatest?
    (A) $B_1 < B_2 < B_3$
    (B) $B_3 < B_2 < B_1$
    (C) $B_1 = B_2 = B_3$
    (D) $B_1 < B_2 = B_3$

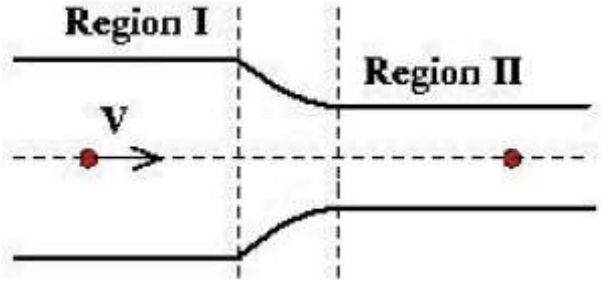
11. Two objects labeled K and L have equal mass but densities $0.95D_o$ and D_o, respectively. Each of these objects floats after being thrown into a deep swimming pool. Which is true about the buoyant forces acting on these objects?
    (A) The buoyant force is greater on Object K since it has a lower density and displaces more water.
    (B) The buoyant force is greater on Object K since it has lower density and lower density objects always float "higher" in the fluid.
    (C) The buoyant force is greater on Object L since it is denser than K and therefore "heavier."
    (D) The buoyant forces are equal on the objects since they have equal mass.

12. 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) $8.0\times10^{-4}\ m^3$



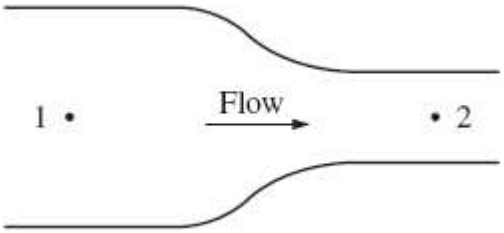
13. A cube of unknown material and uniform density floats in a container of water with 60% of its volume submerged. If this same cube were placed in a container of oil with density 800 kg/m^3, what portion of the cube's volume would be submerged while floating?
    (A) 33% (B) 50% (C) 58% (D) 75%

14. The speed of an ideal fluid is marked as it moves along a horizontal streamline through a pipe, as shown in the figure. In Region I, the speed of the fluid on the streamline is V. The cylindrical, horizontal pipe narrows so that the radius of the pipe in Region II is half of what it was in Region I. What is the speed of the marked fluid when it is in Region II?



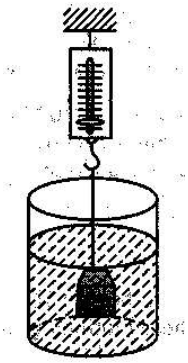
(A) 4V (B) 2V (C) V/2 (D) V/4

15. A fluid flows steadily from left to right in the pipe shown. The diameter of the pipe is less at point 2 then at point 1, and the fluid density is constant throughout the pipe. How do the velocity of flow and the pressure at points 1 and 2 compare?



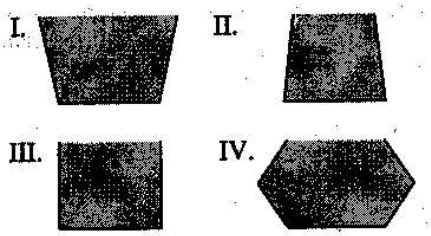
Velocity	Pressure
(A) $v1 < v2$	$p1 = p2$
(B) $v1 < v2$	$p1 > p2$
(C) $v1 = v2$	$p1 < p2$
(D) $v1 > v2$	$p1 = p2$

16. 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



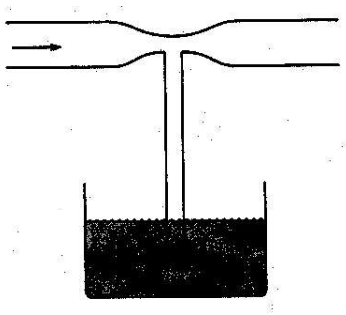
(A) 1.3 N
(B) 1.0N
(C) 0.75 N
(D) 0.33 N

17. Each of the beakers shown is filled to the same depth h with liquid of density ρ. The area A of the flat bottom is the same for each beaker. Which of the following ranks the beakers according to the net downward force exerted by the liquid on the flat bottom, from greatest to least force?



(A) I, III, II, IV
(B) I, IV, III, II
(C) II, III, IV, I
(D) None of the above, the force on each is the same.

18. **Multiple Correct:** A T-shaped tube with a constriction is inserted in a vessel containing a liquid, as shown. What happens if air is blown through the tube from the left, as shown by the arrow in the diagram? Select two answers.



(A) The liquid level in the tube rises to a level above the surface of the liquid in the surrounding tube
(B) The liquid level in the tube falls below the level of the surrounding liquid
(C) The pressure in the liquid in the constricted section increases.
(D) The pressure in the liquid in the constricted section decreases.

19. One cubic centimeter of iron (density ~7.8 g/cm^3) and 1 cubic centimeter of aluminum (density ~2.7 g/cm^3) are dropped into a pool, and they sink to the bottom. Which has the larger buoyant force on it?
(A) iron (B) aluminum (C) both are the same. (D) neither has a buoyant force on it

20. One kilogram of iron (density ~7.8 g/cm^3) and 1 kilogram of aluminum (density ~2.7 g/cm^3) are dropped into a pool, and they sink to the bottom. Which has the larger buoyant force on it?
(A) iron (B) aluminum (C) both are the same. (D) neither has a buoyant force on it

21. Find the approximate minimum mass needed for a spherical ball with a 40 cm radius to sink in a liquid of density 1.4x10^3 kg/m^3
(A) 37.5 kg (B) 375 kg (C) 3750 kg (D) 37500 kg

22. A horizontal pipe of radius 7R carries a uniformly dense liquid to a spigot of radius R, where it has a speed of V. What is the speed of the liquid in the larger diameter pipe?
(A) 0.02V (B) 0.11V (C) V (D) 49V

23. The pressure in a pipe carrying a liquid with a density of ρ and an initial velocity v at the inlet is P, which is y meters lower than its outlet, which has a velocity of 2v. In these terms, what is the final pressure?

$(A)\ \frac{P}{2}\rho\left(3v^2+2gy\right)$

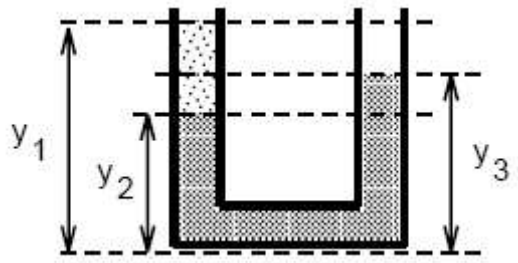
$(B)\ P-\frac{1}{2}\rho\left(3v^2+2gy\right)$

$(C)\ P+\frac{1}{2}\rho\left(-3v^2+\rho gy\right)$

$(D)\ \frac{\frac{1}{2}\rho\left(v^2-4v^2\right)-\rho gy}{P}$

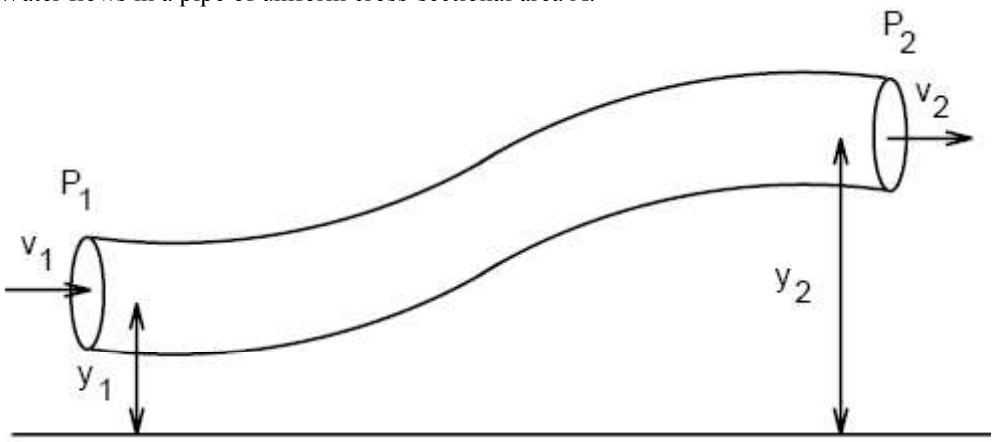
24. A block of mass m, density ρ_B , and volume V is completely submerged in a liquid of density ρ_L. The density of the block is greater than the density of the liquid. The block
(A) floats, because $\rho_B > \rho_L$
(B) experiences a buoyant force equal to ρ_B gV.
(C) experiences a buoyant force equal to ρ_L gV.
(D) experiences a buoyant force equal to m_B g

25. **Multiple Correct:** 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? (Select two answers.)
(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 the same as 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.

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

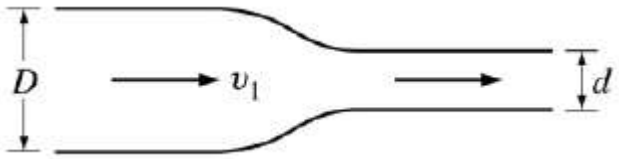


The pipe changes height from $y_1 = 2$ meters to $y_2 = 3$ meters. Since the areas are the same, we can say $v_1 = v_2$. Which of the following is true?
(A) $P_1 = P_2 + \rho g(y_2 - y_1)$
(B) $P_1 = P_2$
(C) $P_1 = 0$
(D) $P_2 = 0$

27. 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) 10^2 Pa
(B) 10^3 Pa
(C) 10^4 Pa
(D) 10^5 Pa

28. A ball that can float on water has mass 5.00 kg and volume 2.50 x 10^{-2} m^3. What is the magnitude of the downward force that must be applied to the ball to hold it motionless and completely submerged in fresh water of density 1.00 x 10^3 kg/m^3?
(A) 20.0 N
(B) 25.0 N
(C) 30.0 N
(D) 200 N

29. Water flows through the pipe shown. At the larger end, the pipe has diameter D and the speed of the water is v_1 .



What is the speed of the water at the smaller end, where the pipe has diameter d ?

$(A)\ \frac{d}{D}v_1 \qquad (B)\ \frac{D}{d}v_1 \qquad (C)\ \frac{d^2}{D^2}v_1 \qquad (D)\ \frac{D^2}{d^2}v_1$