Chapter 13: Fluids

Important Formulas

$$\text{Density } \rho = \frac{m}{V}$$

$$\begin{aligned}\text{Buoyant Force } B &= \text{weight of displaced fluid} \\ &= m_{\text{displaced fluid}} \times g \\ &= \rho_{\text{fluid}} \times V_{\text{immersed object}} \times g\end{aligned}$$

$$P_2 = P_1 + \rho g h \qquad (h = y_1 - y_2)$$

$$\text{Flow Rate } R = A\,v$$

$$A_1\,v_1 = A_2\,v_2$$

$$P_1 + \frac{1}{2}\rho v_1 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2 + \rho g y_2$$

$$\text{Area of a circle } A = \pi r^2$$

Atmospheric pressure 1 atm = 1.01×10^5 Pa.

Density of water at room temperature = 1000 kg/m^3.

centi (c) = 10^{-2}, *milli* (m) = 10^{-3}, *micro* (μ) = 10^{-6}, *nano* (n) = 10^{-9},

kilo (k) = 10^3, *Mega* (M) = 10^6, *Giga* (G) = 10^9

Buoyancy Forces

Q1. A block of wood with length = 2.5 m, width = 0.5 m and height = 0.4 m. The density of water is 1000 kg/m^3. If the block is fully immersed in the water, what is the buoyant force?

A) 0.5 N **B)** 500 N **C)** 4900 N **D)** 9800 N

Q2. A wooden cubic block with dimensions of 1 m × 1 m × 1 m is thrown into a water pool. If only half of the cube was immersed in water while the other half was floating.

Part 1: Calculate the buoyancy force exerted by water on the cube (density of water = 1000 kg/m^3)?

A) 500 N **B)** 1000 N **C)** 4900 N **D)** 9800 N

Part 2: What is the density of the wooden cube?

A) 500 kg/m^3 **B)** 1000 kg/m^3 **C)** 4900 kg/m^3 **D)** 9800 kg/m^3

Continuity Equation

Q3. If the flow rate of blood through human aorta is about 90 cm^3/s. If the aortahas has a radius of 1.0 cm, the velocity of the blood flow is:

A) 14.17 cm/s **B)** 32.23 cm/s **C)** 37.51 cm/s **D)** 28.65 cm/s

Q4. A horizontal pipe contains water at pressure of 10^5 Pa with speed of 1.4 m/s. When the pipe narrows to one-half its original radius, the speed is:

A) 5.6 m/s **B)** 10.6 m/s **C)** 13 m/s **D)** 16.7 m/s

Q5. The equation of continuity is:

A) valid only for stream line flow of fluids
B) valid only for turbulent flow of fluids
C) valid for turbulent and stream line flow of fluids
D) NOT valid for both turbulent and stream line flow of fluids
E) NOT depending on the fluid flow

Q6. Water runs in a pipe of 20 mm diameter at a velocity of 5 m/s. The pipe needs to be connected to a hose of smaller diameter. The diameter of the hose so that water flows at 15 m/s should be:

A) 6.67 mm **B)** 11.5 mm **C)** 44.4 mm **D)** 60 mm

Q7. A man uses a hose to water his garden. The water enters the hose through a small hole with a 6.0 cm diameter. The speed of the water at the faucet is 5 m/s. If the small hole and the nozzle are at the same height, and the water leaves the nozzle with a speed of 20 m/s, the diameter of the nozzle is:

A) 2.0 cm **B)** 3.0 cm **C)** 4.0 cm **D)** 6.0 cm

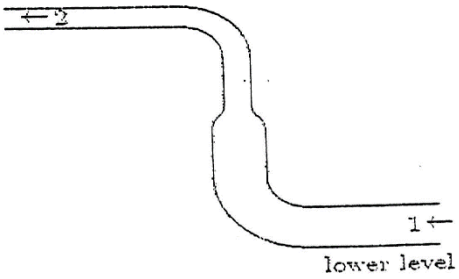
Bernoulli's Equation

Q8. If water is pumped at a speed of 0.5 m/s through pipe within a circulating system in the basement at pressure of 3 atm. If the flow speed of the water in the second floor 5.0 m above the basement is v = 1.183 m/s. The pressure in the second floor will be:

A) 2.5×10^5 Pa **B)** 3.3×10^3 Pa **C)** 5.8×10^5 Pa **D)** 1.9×10^4 Pa

Q9. Water is pumped through the hose shown below, from a lower level to an upper level. Compared to the water at point 1, the water at point 2:

A) has a greater speed and greater pressure
B) has a greater speed and less pressure
C) has less speed and less pressure
D) has less speed and greater pressure
E) has a greater speed and the same pressure



Q10. A big closed water tank has a constant pressure of 2 atm at its top. A small hole is made at a distance of 4 m below the water tank level. The velocity of the water is:

A) 6.8 m/s **B)** 11.3 m/s **C)** 9.6 m/s **D)** 16.7 m/s

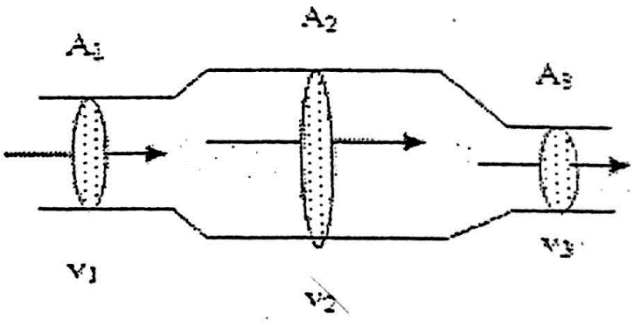
Q11. Which of the following is true for the pressures in each section of the pipe:

A) $P_1 > P_2 > P_3$

B) $P_2 > P_1 > P_3$

C) $P_3 > P_2 > P_1$

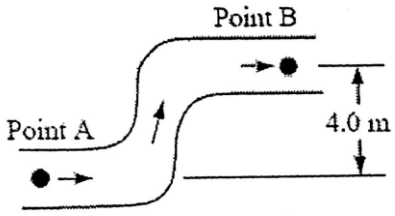
D) $P_2 > P_3 > P_1$



Q12. Water (density = 1.0×10^3 kg/m^3) flows through a horizontal tapered pipe. At the wide end its speed is 4.0 m/s. The difference in pressure between the two ends is 4.5×10^3 Pa. The speed of the water at the narrow end is:

A) 5.0 m/s **B)** 3.4 m/s **C)** 4.0 m/s **D)** 2.6 m/s

Q13. Oil (ρ = 925 kg/m^3) is flowing through a pipeline at a constant speed when it encounters a vertical bend in the pipe raising it 4.0 m. The cross sectional area of the pipe does not change. The difference in pressure ($P_B - P_A$) in the portions of the pipe before and after the rise is:



A) -3.6×10^4 Pa **B)** -7.2×10^5 Pa **C)** $+2.4 \times 10^4$ Pa **D)** -1.8×10^3 Pa

Q14. A horizontal pipe 10.0 cm in diameter has a smooth reduction to a pipe 5.00 cm in diameter. If the pressure of the water in the larger pipe is 8.00×10^4 Pa, and the pressure in the smaller pipe is 6.00×10^4 Pa, then the velocity of water inside the larger pipe is:

A) 1.82 m/s **B)** 1.63 m/s **C)** 2.21 m/s **D)** 3.26 m/s

Q15. Water flows through a horizontal pipe. The diameter of the pipe at point B is larger than at point A. The greatest water pressure is at:

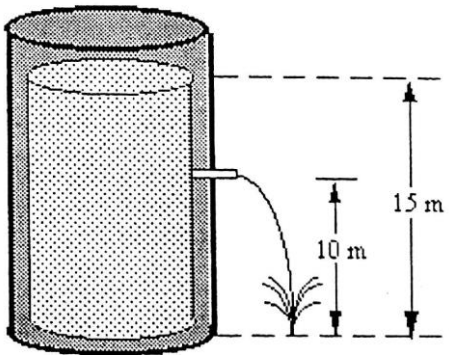
A) point A
B) point B
C) same at both A and B
D) somewhere between A and B
E) cannot be determined from the information given

Q16. Water flows at 12 m/s in a horizontal pipe with a pressure of 3.0×10^4 N/m^2. If the pipe diameter is doubled, the pressure in the wider section in N/m^2 is:

(assume the density of water is equal to 1000 kg/m^3)

A) 3.0×10^3 **B)** 4.9×10^3 **C)** 7.4×10^4 **D)** 9.8×10^4

Q17. A large closed tank is filled with water to a depth of 15 cm. A small hole located 10.0 m above the bottom of the tank is then opened as shown in the drawing. The speed of water emerging out of the hole is:



A) 3.1 m/s **B)** 17 m/s **C)** 9.9 m/s **D)** 14 m/s