Name	Section	Date	Score
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Phys 20.01 Group homework 5

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2025 W49

Instructions: For comprehension and conceptual questions, choose the best answer. For problem-solving questions, choose the best answer and show your solution and reasoning. Comprehension is 1 pt each, conceptual is 2 pt each, and problem-solving is 3 pt each.

1. Comprehension

1. Which statement does not apply? In the steady flow of an incompressible fluid,
   a. the flow velocity at a point is tangent to the streamline through that point
   b. the wider the streamline spacing, the lower the velocity of the flow
   c. the density of the fluid is proportional to the density of streamlines
   d. streamlines cannot cross each other

2. The buoyant force on an immersed body has the same magnitude as
   a. the weight of the body
   b. the weight of the fluid displaced by the body
   c. the difference between the weights of the body and the displaced fluid
   d. the average pressure of the fluid times the surface area of the body

3. The equation of continuity says that the velocity of fluid flow in a pipe is inversely proportional to the cross-sectional area
   a. only for an incompressible fluid
   b. only for a horizontal pipe
   c. both of the above
   d. always

4. Bernoulli's equation is a conservation law for
   a. streamlines
   b. momentum
   c. energy
   d. mass

5. Does pressure in a stationary fluid have a direction?
   a. Yes, it always acts downwards due to gravity
   b. Yes, it acts in the direction of the flow
   c. No, it is a vector that cancels itself out
   d. No, it is a scalar and only acts perpendicular to any surface it contacts

6. If you have 1,000 kg of aluminum and 1,000 kg of lead, which has the greater volume?
   a. Lead
   b. Aluminum
   c. They have same volume as they have same mass
   d. It is impossible to tell without knowing the shape

7. A boulder is thrown into a deep lake. As it sinks deeper & deeper, what happens to buoyant force acting on it?
   a. It increases, as column of water above it is heavier
   b. It increases, as pressure increases with depth
   c. It decreases, as the water becomes colder and denser
   d. It remains unchanged

8. Which of the following correctly describes the relationship between specific gravity and density?
   a. Specific gravity is the density of an object minus the density of air
   b. Specific gravity is the volume of the object divided by the volume of water it displaces
   c. Specific gravity is the mass of the object multiplied by acceleration due to gravity g
   d. Specific gravity is the ratio of an object's density to the density of water at 4°C

9. When calculating the height required for an IV bag to overcome venous pressure, which physical concept is primarily used?
   a. Bernoulli's principle
   b. Pascal's law $F_1/A_1 = F_2/A_2$
   c. Archimedes' principle $B = \rho V g$
   d. Hydrostatic pressure $p = \rho g h$

10. Why is ketchup (a viscous fluid) less likely to become turbulent than water flowing at the same speed?
    a. Ketchup is denser than water
    b. Ketchup is a non-newtonian fluid
    c. High viscosity increases the Reynolds number
    d. High viscosity suppresses turbulence and encourages laminar flow

11. What is the approximate difference in gauge pressure between the systolic and diastolic phases in a healthy young adult?
    a. 120 mm Hg
    b. 80 mm Hg
    c. 40 mm Hg
    d. 4 mm Hg

12. The pressure at bottom of a pond doesn't depend on
    a. water density
    b. depth of the pond
    c. surface area of the pond
    d. acceleration due to gravity

13. Atmospheric pressure is due to the weight
    a. of the atmosphere
    b. of planet earth itself
    c. and volume of the atmosphere

d. density and volume of the atmosphere

14. Water flows through a horizontal pipe. If the pipe narrows such that the radius of the pipe is reduced to half of its original size ($r_2 = 0.5r_1$), what happens to the flow speed v_2 compared to the initial speed v_1?
    a. The speed doubles ($2v_1$)
    b. The speed quadruples ($4v_1$)
    c. The speed decreases by half ($0.5v_1$)
    d. The speed stays the same

15. In the context of fluid dynamics, what does the continuity equation $A_1 v_1 = A_2 v_2$ physically represent?
    a. conservation of mass
    b. conservation of energy
    c. conservation of pressure
    d. conservation of momentum

16. How does temperature affect the viscosity of fluids?
    a. Viscosity is independent of temperature
    b. Heating always decreases viscosity for all fluids
    c. Heating increases viscosity for liquids but decreases it for gases
    d. Heating decreases viscosity for liquids but increases viscosity for gases

2. Conceptual

1. A specific quantity of water freezes into ice. According to density properties described, which of these statements regarding its mass and volume is correct?
    a. The mass decreases, causing density to decrease
    b. The volume decreases, causing density to increase
    c. The mass remains constant, but volume expands, decreasing the density
    d. The volume remains constant, but mass increases, increasing the density

2. When a hole is made in the side of a container holding water, the water flows out in a parabolic trajectory. If the container is dropped in free fall, the water flow
    a. diminishes
    b. stops altogether
    c. goes out in a straight line
    d. curves upward

3. Two large trucks are driving fast in opposite directions on a highway and pass close to each other. Physics predicts they will
    a. be pushed apart by the air cushion between them
    b. be pulled toward each other
    c. experience no lateral force
    d. lift slightly off the ground

4. Why does a stream of honey poured from a spoon get narrower as it falls?
    a. As the honey falls, gravity accelerates it, so to conserve mass flux, the area must decrease
    b. The viscosity of the honey increases as it moves away from the spoon
    c. The air pressure compresses the honey
    d. Surface tension squeezes the stream

5. In the circulatory system, mean blood velocity drops from about 25 cm/s in aorta to about 1 mm/s in capillaries. This velocity decrease is primarily due to
    a. the extreme friction and viscosity experienced in the small vessels
    b. the drastic increase in the total cross-sectional area of the capillary bed
    c. the loss of pulsatile pressure from the heart
    d. the decrease in blood density as it loses oxygen

6. A container is filled with oil and fitted on both ends with pistons. The area of the left piston is 10 mm^2, while that of the right piston is $10,000$ mm^2. What force must be exerted on the left piston to keep the 10,000-N car on the right at the same height?
    a. 10 N
    b. 100 N
   c. $10,000$ N
    d. 10^6 N
    e. 10^8 N
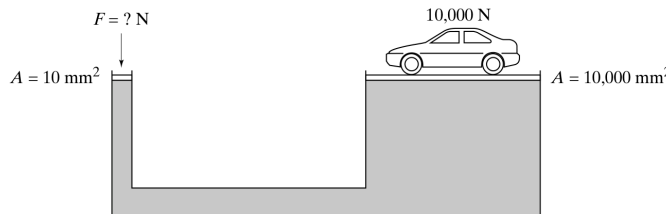
7. Two cups are filled to the same level with water. One cup has ice cubes floating in it. Which weighs more?
    a. The cup without ice cubes
    b. The glass with ice cubes
    c. The two weigh the same

8. When the ice cubes melt, in which cup is the level of the water higher?
    a. The cup without ice cubes
    b. The glass with ice cubes
    c. It is the same in both

9. A boat carrying a large boulder is floating on a lake. The boulder is thrown overboard and sinks. The water level in the lake (with respect to the shore)
    a. rises
    b. drops
    c. remains the same

10. Consider an object that floats in water but sinks in oil. When the object floats in water, half of it is submerged. If we slowly pour oil on top of the water so it completely covers the object, the object
    a. moves up
    b. moves down
    c. stays in the same place

11. A circular hoop sits in a stream of water, oriented perpendicular to the current. If the area of the hoop is doubled, the flux (volume of water per unit time) through it
    a. decreases by a factor of 4
    b. decreases by a factor of 2
    c. remains the same

d. increases by a factor of 2
e. increases by a factor of 4

12. In the skeletal system, improper lifting can result in damaging pressures on spinal discs. If a force of 5000 N is applied to a disc area of 10 cm^2, resulting pressure is
    a. 5×10^3 Pa
    b. 5×10^4 Pa
    c. 5×10^5 Pa
    d. 5×10^6 Pa

13. Glaucoma involves a high intraocular pressure. Mechanically, how does the eye respond to this increased internal fluid pressure?
    a. deforms less under force, rebounds more vigorously
    b. becomes more elastic, absorbs external forces easily
    c. expands significantly, relieving pressure naturally
    d. The fluid viscosity decreases to compensate

14. Blood flows through a coronary artery that is partially blocked by deposits along the artery wall. Through which part of the artery is the flow speed largest?
    a. the narrow part
    b. the wide part
   c. the speed is the same in both parts
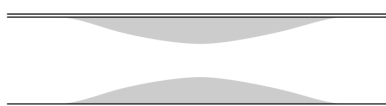
15. A blood platelet drifts along with the flow of blood through an artery that is partially blocked by deposits. As the platelet moves from the narrow region to the wider region, it experiences
    a. an increase in pressure
    b. a decrease in pressure
    c. no change in pressure

16. Rank for the percentage of its volume above the water line, from greatest to least.
    • A: basketball floating in fresh water
    • B: basketball floating in saltwater
    • C: basketball floating in mercury

    a. A, B, C
    b. A, C, B
    c. C, A, B
    d. C, B, A
    e. No ranking because A = B = C

17. Think about what happens to the volume of an air-filled balloon on top of water and beneath the water. Then rank the buoyant forces on a weighted balloon in water, from greatest to least, when it is
    • A: barely floating with its top at the surface
    • B: pushed 1 m beneath the surface
    • C: pushed 2 m beneath the surface

    a. A, B, C
    b. A, C, B
    c. C, A, B
    d. C, B, A
    e. No ranking because A = B = C
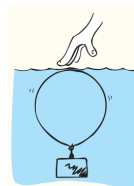
18. Rank the buoyant forces supplied by the atmosphere on the following, from greatest to least.
    • A: an elephant
    • B: a helium-filled party balloon
    • C: a skydiver at terminal velocity

    a. A, B, C
    b. A, C, B
    c. C, A, B
    d. C, B, A
    e. No ranking because A = B = C

3. Problem solving

Rockin'. In the lab, you find that a 1-kg rock suspended above water weighs 10 N. When the rock is suspended beneath the surface of the water, the scale reads 8 N.

1. What is the buoyant force on the rock?
   a. 2 N
   b. 8 N
   c. 10 N
   d. 12 N
   e. 18 N
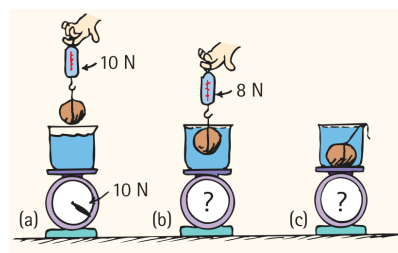
The buoyant force on the rock is the difference between its true weight (weight in air) and its apparent weight when submerged in the water:

$$B = W_{\text{air}} - W_{\text{app}} = 10 \text{ N} - 8 \text{ N} = 2 \text{ N}$$

2. If the container of water weighs 10 N on the weighing scale, what is the scale reading when the rock is suspended beneath the surface of the water?
   a. 2 N
   b. 8 N
   c. 10 N
   d. 12 N
   e. 18 N

As per Archimedes' principle, the buoyant force on the rock is equal to the weight of the water displaced by the rock (which as per previous calculation is $B = 2$ N).

The total reading on the weighing scale under the container in scenario (b) is then the sum of the original weight of the container and the additional downward force exerted by the rock on the water, that is

$$\text{total scale reading} = 10 \text{ N} + 2 \text{ N} = 12 \text{ N}$$

Bernoulli's. Pick one and write down your reasoning.

1. Which best explains why when a fast-moving train passes a train at rest, they tend to be drawn together?
   a. intense suction
   b. reduced pressure
   c. increased pressure
   d. higher air resistance

When the fast train passes, the air velocity in the narrow gap between the two trains increases significantly. As per Bernoulli's principle, this increase in speed leads to a reduction in pressure within the gap. Since the pressure on the outside of the trains remains higher (atmospheric pressure), the resulting pressure differential creates a net force that pushes both trains inward, drawing them together.