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## Fluids and Pressure

### Study Guide — Fluids & Pressure

Pre-med/IB-style questions on pressure, density, hydrostatics, Pascal's principle and hydraulics, buoyancy (Archimedes), atmospheric pressure devices, continuity and Bernoulli flow ideas, viscosity/laminar flow, and surface tension/capillarity. Emphasis on conceptual traps and real-world reasoning.

75 items — Study Guide with Answers

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1 Pressure is best defined as:

- A Force multiplied by area
- B Force divided by area ✓**
- C Energy divided by time
- D Charge divided by time
- E Mass divided by volume

► **Explanation:** Pressure measures how concentrated a force is:  $P = F/A$ . A is wrong (that would have the wrong meaning/units). C is power, D is current, E is density.



2 A person stands on snow wearing boots. If they switch to skis (larger contact area) while their weight stays the same, the pressure on the snow:

- A Increases
- B Decreases ✓**
- C Stays the same
- D Becomes zero
- E Depends only on snow temperature

► **Explanation:** With the same force (weight) and larger area,  $P = F/A$  decreases. The key idea is pressure changes when area changes, even if force is unchanged.



3 A student stands still on one foot instead of two (same weight). Compared with standing on two feet, the pressure on the ground is:

- A About half





- B About double ✓**
- C Unchanged
- D Zero because there is no motion
- E Less because balance requires less force

► **Explanation:** Weight (force) is the same, but contact area is roughly halved, so  $P = F/A$  roughly doubles. Motion is irrelevant (D).

**4 The SI unit of pressure (pascal, Pa) is equivalent to:**



- A  $N \cdot m$
- B  $N/m$
- C  $N/m^2$  ✓**
- D  $kg/m^2$
- E  $J/s$

► **Explanation:** Since  $P = F/A$ , the unit is  $N/m^2$ .  $N \cdot m$  is a joule, and  $J/s$  is a watt.

**5 In a fluid at rest, the pressure at a point acts:**



- A Only downward
- B Only upward
- C Only sideways
- D Equally in all directions ✓**
- E Only along the direction of flow





► **Explanation:** In a static fluid, pressure is isotropic: it acts equally in all directions at a point. Directional effects are from pressure differences, not from pressure itself.

**6** Two points are at the same depth in the same connected body of still water (same surface pressure). The pressure at these two points is:



- A Higher at the point directly under the surface center
- B Higher at the point under the wider part of the container
- C The same at both points ✓**
- D Higher at the point closer to the wall
- E Unpredictable without knowing container shape

► **Explanation:** Hydrostatic pressure depends only on depth (and fluid density and  $g$ ) when the fluid is at rest:  $P = P_{\text{surface}} + \rho gh$ . Container shape does not matter.

**7** Which change would increase the pressure at a point 2 m below the surface of a lake (assuming the lake surface pressure stays atmospheric)?



- A Replacing water with a less dense liquid
- B Decreasing the depth of the point
- C Replacing water with a more dense liquid ✓**
- D Making the lake wider
- E Stirring the lake gently

► **Explanation:**  $P = P_0 + \rho gh$ , so increasing density increases pressure at the same depth. Width and gentle stirring don't change hydrostatic pressure at a given depth.





8 A container is filled with water to height  $h$ . Which statement about the pressure at the bottom is correct (water at rest, open to atmosphere)?



- A It depends on the container's shape
- B It depends only on the base area
- C It depends on water height  $h$  (and  $\rho$  and  $g$ ), not on shape ✓
- D It is always equal to atmospheric pressure
- E It is zero at the bottom

► **Explanation:** Bottom pressure is  $P_{\text{bottom}} = P_{\text{atm}} + \rho gh$ . Shape affects total force on the base only via area, but pressure at a given depth depends on height, not shape.

9 Two containers have the same water height  $h$  but different base areas. Which statement is correct about the FORCE from the water on the base (ignoring the container material)?



- A The force is the same because pressure is the same
- B The container with larger base area has larger force because  $F = PA$  ✓
- C The force is larger in the narrow container because water is "more concentrated"
- D Force depends only on the mass of water, not area
- E The force must be zero if the water is at rest

► **Explanation:** At the same depth, pressure  $P$  is the same, but force on the base is  $F = PA$ . Larger area means larger force even with the same pressure.

10 Gauge pressure is best described as:



- A Pressure measured relative to vacuum





- B Pressure measured relative to atmospheric pressure ✓**
- C Pressure measured only in liquids
- D Pressure that cannot be negative
- E Pressure multiplied by volume

► **Explanation:** Gauge pressure uses atmospheric pressure as the zero reference:  $P_{\text{gauge}} = P_{\text{absolute}} - P_{\text{atm}}$ . It can be negative if  $P_{\text{absolute}} < P_{\text{atm}}$ .

**11 A tire pressure gauge reads 2.0 bar. This measurement is most likely:**



- A Absolute pressure inside the tire
- B Gauge pressure above atmospheric pressure ✓**
- C The pressure at the center of the tire only
- D The pressure difference between two sides of the tire
- E The pressure outside the tire

► **Explanation:** Most tire gauges report pressure above atmospheric pressure (gauge pressure), not absolute pressure. Absolute pressure would be gauge + atmospheric.

**12 In a U-tube manometer containing the same liquid in both arms, a height difference  $\Delta h$  between the columns indicates that the pressure difference between the two connected points is proportional to:**



- A  $\Delta h$  only
- B only
- C  $g\Delta h$  ✓**
- D  $g/\Delta h$





E  $\Delta h^2$

► **Explanation:** The hydrostatic pressure difference is  $\Delta P = \rho g \Delta h$ . Larger density or larger height difference means larger pressure difference.

13 If you use a denser manometer liquid (e.g., mercury instead of water) to measure the same pressure difference, the height difference  $\Delta h$  will be:



- A Larger
- B **Smaller** ✓
- C The same
- D Zero
- E Negative

► **Explanation:** For fixed  $\Delta P$ ,  $\Delta h = \Delta P / (\rho g)$ . Increasing  $\rho$  makes  $\Delta h$  smaller. This is why mercury columns can be relatively short for atmospheric pressure.

14 A mercury barometer works because:



- A Mercury is magnetic and is pulled upward
- B **Atmospheric pressure pushes on the mercury reservoir and supports a column of mercury** ✓
- C A pump inside the tube pulls mercury up continuously
- D The vacuum above mercury pulls it upward
- E Mercury creates its own pressure upward

► **Explanation:** Atmospheric pressure on the reservoir supports the mercury column. The space at the top is (approximately) a vacuum, so there's no opposing air pressure there.





15 Why can you drink through a straw (ignoring viscosity limits)?



- A Because you pull the liquid upward with your mouth like a vacuum cleaner
- B Because you reduce pressure inside the straw and atmospheric pressure pushes the liquid up ✓**
- C Because gravity pulls the liquid up the straw
- D Because liquids naturally rise in narrow tubes no matter what
- E Because your mouth adds mass to the liquid

► **Explanation:** You lower the pressure in the straw; atmospheric pressure on the drink surface pushes liquid up into the region of lower pressure. You don't "pull" liquids with suction as a force from your mouth.

16 A diver goes deeper in the ocean. The main reason the pressure increases is:



- A The diver's mass increases with depth
- B Water becomes less dense with depth so pressure rises
- C There is more water above, so the weight of the water column increases pressure ✓**
- D Atmospheric pressure increases underwater
- E Pressure increases because the diver moves faster

► **Explanation:** Hydrostatic pressure rises with depth because of the weight of the fluid above:  $P = P_{\text{surface}} + gh$ . The diver's mass and speed do not set the pressure.





**17** Two points are at the same depth: one in oil and one in water. Both liquids are open to the same atmospheric pressure. If oil is less dense than water, the pressure at the point in oil is:

- A Greater because oil is thicker
- B The same because depth is the same
- C Smaller because  $\rho$  is smaller in  $P = P_0 + \rho gh$  ✓**
- D Zero because oil floats
- E Unpredictable without container shapes

► **Explanation:** At the same depth, the hydrostatic term is  $\rho gh$ . Lower density means lower pressure increase from the surface pressure.



**18** Pascal's principle states that:

- A Pressure in a moving fluid decreases as speed increases
- B A pressure change applied to an enclosed fluid is transmitted undiminished throughout the fluid ✓**
- C Buoyant force equals the weight of displaced fluid
- D Fluid flows from low pressure to high pressure
- E Pressure depends on container shape

► **Explanation:** Pascal's principle: in an enclosed (nearly incompressible) fluid at rest, an applied pressure change spreads through the fluid. A is Bernoulli, C is Archimedes.



**19** A hydraulic lift has a small piston area  $A_1$  and a large piston area  $A_2$ , with  $A_2 > A_1$ . If a force  $F_1$  is applied to the small piston, the output force  $F_2$  on the large piston (ideal system) is:





- A  $F_2 = F_1$
- B  $F_2 = F_1(A_1/A_2)$
- C  **$F_2 = F_1(A_2/A_1)$  ✓**
- D  $F_2 = F_1 + (A_2 - A_1)$
- E  $F_2 = F_1(A_1 + A_2)$

► **Explanation:** By Pascal's principle, pressure is transmitted:  $F_1/A_1 = F_2/A_2$ , so  $F_2 = F_1(A_2/A_1)$ . Larger area gives larger force (mechanical advantage).

**20** In the same hydraulic lift (ideal), if the large piston produces 10 times the force of the small piston, then the large piston must move:



- A 10 times farther than the small piston
- B The same distance as the small piston
- C **1/10 the distance of the small piston ✓**
- D 100 times farther than the small piston
- E In the opposite direction

► **Explanation:** Volume conservation for incompressible fluid:  $A_1d_1 = A_2d_2$ . If  $A_2/A_1 = 10$ , then  $d_2 = d_1/10$ . Force gain comes with distance loss (energy conservation).

**21** In an ideal hydraulic system (no losses), which statement about work is correct?



- A Output work is greater because force is amplified
- B Input work is greater because small piston is smaller
- C **Input work equals output work (ignoring losses) ✓**





- D No work is done because the fluid is at rest
- E Work depends only on pressure, so it cancels to zero

► **Explanation:** Ideal hydraulics obey energy conservation:  $W_{in} = F_1d_1$  equals  $W_{out} = F_2d_2$ . You trade force for distance, not create extra work.

**22** Buoyant force (upthrust) on an object fully or partially submerged in a fluid equals:



- A The object's weight
- B **The weight of the displaced fluid** ✓
- C The mass of the displaced fluid
- D The pressure at the top surface only
- E The fluid's weight

► **Explanation:** Archimedes' principle: upthrust equals the weight of the fluid displaced ( $\rho_{fluid} g V_{displaced}$ ). It does not automatically equal the object's weight unless floating in equilibrium.

**23** An object floats at rest in water. Which statement must be true?



- A **The object's weight equals the buoyant force** ✓
- B The buoyant force is greater than the object's weight
- C The object's density is greater than water
- D The object displaces its own volume of water
- E The pressure at the bottom of the object is zero

► **Explanation:** Floating at rest means net force is zero, so buoyant force equals weight. If buoyant force were greater, it would accelerate upward.





**24** An object is fully submerged and suspended in a fluid without touching the bottom. If the fluid is incompressible and the object's volume does not change, the buoyant force depends on:



- A Only the object's mass
- B Only the object's depth below the surface
- C The fluid density and the object's volume ✓**
- D Only the container's shape
- E Only the atmospheric pressure

► **Explanation:** Upthrust =  $\rho_{\text{fluid}} g V_{\text{displaced}}$ . For a fully submerged rigid object,  $V_{\text{displaced}}$  is the object volume. Depth increases pressure everywhere but does not change the pressure difference top-to-bottom for the same height.

**25** A steel ship floats in water because:



- A Steel is less dense than water
- B The ship's average density (including air inside) is less than water ✓**
- C Water exerts no pressure on steel
- D Gravity is weaker on ships
- E The ship pushes water downward which cancels its weight

► **Explanation:** Floating depends on average density and displaced volume. Although steel is dense, the ship encloses air so its overall average density can be below water, allowing enough displaced water weight to match the ship's weight.





26 A block sinks in fresh water but floats in salt water. The best explanation is:



- A Salt water has smaller density so buoyant force is smaller
- B Salt water has larger density so buoyant force for the same displaced volume is larger ✓**
- C Salt water has lower pressure so objects float
- D Fresh water exerts buoyancy only on metals
- E Buoyancy depends only on the object's weight

► **Explanation:** Upthrust is  $\rho_{\text{fluid}} g V_{\text{displaced}}$ . Salt water's higher density gives a larger buoyant force for the same displacement, so the object can float there even if it sinks in fresh water.

27 A sealed balloon filled with helium rises in air mainly because:



- A Helium has negative weight
- B Air pressure is zero at ground level
- C The buoyant force from displaced air exceeds the balloon's weight ✓**
- D Helium pushes downward on the Earth
- E The balloon is pulled upward by the vacuum of space

► **Explanation:** The balloon displaces air; the buoyant force equals the weight of displaced air. If that buoyant force is greater than the total weight (balloon + helium), there is a net upward force and it rises.

28 A rock is weighed in air and then weighed while fully submerged in water using a spring balance. The reading in water is smaller because:



- A The rock loses mass in water





- B Gravity is weaker in water
- C Buoyant force acts upward, reducing the tension in the spring ✓**
- D Water pushes downward on the rock
- E Water removes the rock's weight completely

► **Explanation:** The balance measures tension. When submerged, there's an upward buoyant force, so the spring needs less tension to balance the rock's weight, giving a lower reading (apparent weight).

**29** A rigid object is fully submerged in a large tank of water and held stationary. If you move it deeper while keeping it fully submerged, the buoyant force (assuming water incompressible) will:



- A Increase because pressure is higher deeper down
- B Decrease because pressure squeezes the object
- C Stay the same because displaced volume stays the same ✓**
- D Become zero at great depth
- E Reverse direction

► **Explanation:** Buoyant force depends on displaced volume and fluid density:  $\rho V$ . While absolute pressure increases with depth, the pressure difference between bottom and top of the object (for the same height) stays the same in an incompressible fluid.

**30** A compressible balloon is fully submerged in water. As it is taken deeper, its volume decreases. The buoyant force on it will tend to:



- A Increase because pressure increases
- B Decrease because displaced volume decreases ✓**
- C Stay constant because buoyancy depends only on depth





- D Become negative (downward buoyancy)
- E Become independent of fluid density

► **Explanation:** Upthrust is  $gV_{\text{displaced}}$ . If the balloon compresses, it displaces less water, so buoyant force decreases even though pressure is higher.

**31** A floating iceberg melts completely in the ocean. Ignoring temperature and salinity changes, the sea level will:



- A Rise
- B Fall
- C Stay the same ✓
- D Oscillate up and down
- E Become zero

► **Explanation:** A floating object displaces a volume of water whose weight equals the object's weight. When it melts, it turns into the same mass of water, which occupies exactly the volume that had been displaced (to support its weight).

**32** A wooden block floats in water. If the block is cut exactly in half (two smaller blocks), then each half will float:



- A More deeply because it is smaller
- B Less deeply because it is lighter
- C With the same fraction submerged as before ✓
- D Only if the cut surface is vertical
- E Not at all because the block is no longer sealed





► **Explanation:** Floating fraction depends on density ratio: fraction submerged =  $\rho_{\text{object}} / \rho_{\text{fluid}}$ . Cutting the block changes mass and volume proportionally, leaving density the same, so the same fraction is submerged.

**33** A block has density 0.80 times the density of water. When floating at rest, the fraction of its volume submerged is closest to:



- A 0.20
- B 0.50
- C 0.80 ✓
- D 1.00
- E 1.25

► **Explanation:** For floating equilibrium:  $\rho_{\text{fluid}} g V_{\text{sub}} = \rho_{\text{obj}} g V_{\text{total}} \rightarrow V_{\text{sub}} / V_{\text{total}} = \rho_{\text{obj}} / \rho_{\text{fluid}} = 0.80$ . Values above 1 are impossible for a floating object.

**34** Continuity equation for steady flow of an incompressible fluid in a pipe states that:



- A Pressure is constant everywhere
- B Speed is constant everywhere
- C Volume flow rate  $Av$  is constant along the pipe ✓
- D Density increases in narrower sections
- E Flow rate depends only on height

► **Explanation:** For incompressible steady flow, the same volume per second must pass each cross-section:  $A_1v_1 = A_2v_2$ . Speed changes when area changes.





**35** Water flows steadily through a horizontal pipe that narrows from a wide section to a narrow section. Compared to the wide section, in the narrow section the water speed is:

- A Smaller
- B The same
- C **Greater** ✓
- D Zero
- E Negative

► **Explanation:** Continuity:  $Av$  is constant. Smaller area requires larger speed for the same flow rate.



**36** For steady incompressible flow in a horizontal pipe (ignoring viscosity), if speed increases in a narrower section, the pressure there is typically:

- A Higher
- B **Lower** ✓
- C The same
- D Zero
- E Undefined because pressure only exists in static fluids

► **Explanation:** Bernoulli (horizontal):  $P + \frac{1}{2} v^2$  is constant along a streamline. Higher  $v$  means lower  $P$  if height is unchanged and losses are neglected.



**37** A garden hose has a nozzle that makes the outlet area smaller. Why does water exit faster from the nozzle?

- A Because pressure always increases in narrower pipes





**B** Because the same flow rate must pass through a smaller area, increasing speed (continuity) ✓

- C** Because water becomes more dense in the nozzle
- D** Because gravity pulls harder at the nozzle
- E** Because Bernoulli says speed decreases when area decreases

► **Explanation:** Continuity is the key:  $A$  decreases so  $v$  increases for the same volume flow rate. Pressure often drops at the nozzle, but the main speed-up comes from the area change requirement.

**38** Water comes out of two small holes in the side of a tank: one hole is near the surface, the other is much deeper. Ignoring viscosity and air resistance, the jet from the deeper hole exits:



- A** Slower because water has more weight above it
- B** At the same speed because both are in the same tank
- C** Faster because the pressure difference driving the flow is larger at greater depth ✓
- D** Only if the tank is wide
- E** Slower because pressure is used up pushing sideways

► **Explanation:** Hydrostatic pressure increases with depth ( $\rho gh$ ), creating a larger pressure head. This produces a higher exit speed (Torricelli's idea:  $v = \sqrt{2gh_{\text{depth}}}$ ).

**39** Two holes at the same depth in a tank: one hole is twice the diameter of the other. Ignoring viscosity, which is correct about the exit speed of water?



- A** The larger hole produces a faster jet
- B** The smaller hole produces a faster jet
- C** Both jets have the same exit speed ✓





- D The exit speed depends on hole area via  $v = Agh$
- E No jet forms from the smaller hole

► **Explanation:** For ideal flow, exit speed depends on pressure head (depth), not on hole size. Hole size affects flow rate (volume per second), not the speed of each fluid element exiting.

**40** A Venturi meter measures flow speed by using the fact that in a narrowing pipe the fluid speed increases and the pressure:



- A Increases
- B Decreases ✓
- C Stays constant
- D Becomes equal to atmospheric pressure
- E Becomes negative by definition

► **Explanation:** Bernoulli explains the Venturi effect: higher speed in the narrow section corresponds to lower static pressure (for the same height and negligible losses).

**41** Why is a shower curtain often pulled inward toward the water stream during a hot shower?



- A Because water molecules attract the curtain electrically
- B Because fast-moving air/water flow near the curtain lowers pressure there, so higher outside air pressure pushes the curtain inward ✓
- C Because the curtain becomes heavier when wet
- D Because gravity reverses inside the shower
- E Because pressure is always higher where speed is higher





► **Explanation:** Moving air and water can reduce pressure locally (Bernoulli-like effect). Higher pressure on the outside of the curtain then pushes it inward. E states the opposite of Bernoulli for same-height flow.

**42** Two strips of paper hang side-by-side with a small gap between them. If you blow air through the gap, the strips tend to move:



- A Apart, because air pushes them outward
- B Together, because faster air between them lowers pressure there ✓
- C Nowhere, because air has no pressure when moving
- D Randomly, because Bernoulli is unpredictable
- E Upward, because air is lighter than paper

► **Explanation:** Faster air in the gap corresponds to lower pressure, so higher pressure on the outer sides pushes the strips toward each other.

**43** An airplane wing generates lift partly because air moves faster over the top surface, making the pressure above the wing:



- A Higher than below, pushing the wing down
- B Lower than below, contributing to an upward net force ✓
- C Exactly equal to below, so lift is impossible
- D Zero because air is a gas
- E Independent of speed because pressure is constant in fluids

► **Explanation:** Bernoulli-type reasoning: higher speed corresponds to lower static pressure (for similar heights), so pressure below can be higher than above, producing upward lift. It's not the only explanation, but it's a common pre-med level one.





**44** In a horizontal pipe narrowing gradually, water speeds up. For the water to speed up, there must be:



- A No net force on the fluid element, because fluids speed up naturally
- B A net force in the direction of flow, which can be provided by a pressure difference
- C A net upward force only
- D Zero pressure everywhere
- E Only gravity providing acceleration

► **Explanation:** Speeding up means acceleration, which requires net force. In a narrowing section, a pressure gradient (higher upstream pressure than downstream) can accelerate the fluid along the pipe.

**45** A pitot tube is used to measure fluid speed by comparing:



- A Temperature and density
- B Static pressure and stagnation (total) pressure
- C Volume and mass
- D Viscosity and surface tension
- E Electric potential and current

► **Explanation:** A pitot tube brings a portion of the flow to rest (stagnation), measuring total pressure. Comparing it to static pressure gives the dynamic pressure related to speed.

**46** Viscosity is best described as a fluid's:



- A Tendency to expand when heated





- B Resistance to flow (internal friction) ✓**
- C Ability to store pressure
- D Density
- E Tendency to float

► **Explanation:** Viscosity measures how strongly a fluid resists deformation/flow due to internal friction. It is different from density.

**47** Flow in a narrow tube is laminar (smooth) at low speeds but can become turbulent at high speeds. Which change is most likely to promote turbulence?



- A Decreasing flow speed
- B Increasing viscosity
- C Increasing flow speed ✓**
- D Making the tube perfectly smooth
- E Using a denser fluid always prevents turbulence

► **Explanation:** Higher speed tends to destabilize flow and promote turbulence. High viscosity tends to damp turbulence (so B is the opposite).

**48** For laminar flow in a cylindrical tube (Poiseuille's idea), the volume flow rate is extremely sensitive to the tube radius. If the tube radius is doubled (same pressure difference), the flow rate changes by a factor of:



- A 2
- B 4
- C 8
- D 16 ✓**





E 1/2

► **Explanation:** In laminar flow, flow rate  $\propto r^4$ . Doubling  $r$  multiplies flow rate by  $2^4 = 16$ . This is why small radius changes matter a lot (e.g., in blood vessels).

49 A blood vessel slightly narrows (vasoconstriction). If everything else stayed the same and flow remained laminar, the resistance to flow would:



- A Decrease slightly
- B Increase strongly ✓
- C Stay the same because pressure adjusts
- D Become zero
- E Change only if density changes

► **Explanation:** Poiseuille: flow resistance increases strongly as radius decreases (roughly  $1/r^4$ ). Small narrowing can significantly reduce flow for a given pressure difference.

50 Surface tension is mainly due to:



- A Gravity pulling surface molecules upward
- B Attractive forces between molecules at the surface creating a "skin-like" effect ✓
- C Air pressure pushing down
- D The density of the liquid being large
- E Electric current in the liquid

► **Explanation:** Molecules at the surface have fewer neighbors above, leading to a net inward attraction that makes the surface behave like it's under tension. It's not primarily due to air pressure or gravity.





51 Detergents help wash dishes partly because they:



- A Increase surface tension so water beads up
- B Decrease surface tension so water spreads and wets surfaces better ✓**
- C Increase density of water
- D Increase hydrostatic pressure
- E Stop capillary action completely

► **Explanation:** Lowering surface tension helps water spread out and penetrate small gaps, improving cleaning. Increasing surface tension would make water bead more.

52 Capillary rise is generally higher in a thinner tube than in a thicker tube because:



- A Pressure is higher in thinner tubes by definition
- B Surface tension effects become more significant relative to the weight of the liquid column in thinner tubes ✓**
- C Gravity is weaker in thinner tubes
- D Thinner tubes create more atmospheric pressure
- E Liquids always rise to the same height regardless of tube radius

► **Explanation:** Capillary action comes from surface tension and adhesion. In narrow tubes, the surface tension force around the circumference can support a taller column before its weight balances it.

53 A soap bubble tends to be spherical because a sphere:



- A Has the largest surface area for a given volume**





- B Has the smallest surface area for a given volume, minimizing surface energy ✓**
- C Has zero pressure inside
- D Is pushed into shape by gravity alone
- E Requires no surface tension

► **Explanation:** Surface tension tends to minimize surface area for a given volume. The sphere minimizes area, so it's the favored shape when gravity is not dominating.

**54 A dam wall must be thicker near the bottom mainly because:**



- A The water is colder at the bottom
- B Pressure increases with depth, so the force per area on the wall is greater at the bottom ✓**
- C Water density is zero at the surface
- D Water flows faster at the bottom
- E Atmospheric pressure is larger at the bottom of a lake

► **Explanation:** Hydrostatic pressure rises with depth ( $\rho gh$ ). That means the lower regions of the dam experience greater pressure and need to be stronger/thicker.

**55 A student says: "The pressure at the bottom of a lake depends on the total volume of water in the lake." The best response is:**



- A Correct, because more water means more pressure
- B Incorrect: bottom pressure depends mainly on depth (and  $\rho$  and  $g$ ), not total volume ✓**
- C Correct only if the lake is circular
- D Correct only if the lake is shallow





- E Incorrect because pressure is always the same everywhere in water

► **Explanation:** Hydrostatic pressure at depth  $h$  is  $P = P_0 + \rho gh$ . Total volume doesn't matter—only the height of fluid above that point (depth) does.

**56** Which principle primarily explains why a hydraulic car jack can lift a car with a relatively small input force?



- A Bernoulli's principle
- B Archimedes' principle
- C **Pascal's principle** ✓
- D Newton's law of gravitation
- E Snell's law

► **Explanation:** Hydraulic systems rely on pressure transmission in an enclosed fluid: Pascal's principle. Bernoulli relates pressure and speed in moving fluids; Archimedes relates to buoyancy.

**57** Which principle primarily explains why pressure can drop in a region where a fluid moves faster along a streamline (same height, negligible viscosity)?



- A Pascal's principle
- B **Bernoulli's principle** ✓
- C Archimedes' principle
- D Hooke's law
- E Ohm's law

► **Explanation:** Bernoulli links speed and pressure in moving fluids: higher speed can correspond to lower static pressure along a streamline at the same height (ignoring losses).





58 Which statement about negative gauge pressure is correct?



- A It means absolute pressure is negative
- B It means the pressure is below atmospheric pressure ✓**
- C It means there is no pressure at all
- D It can never happen because pressure cannot be less than atmospheric
- E It means density is negative

► **Explanation:** Gauge pressure is measured relative to atmosphere. Negative gauge pressure simply means  $P_{\text{absolute}} < P_{\text{atm}}$  (like inside a suction cup or when drawing through a straw). Absolute pressure remains non-negative.

59 A suction cup sticks to a wall mainly because:



- A It creates a region of lower pressure inside, so outside atmospheric pressure pushes it against the wall ✓**
- B It uses magnetism
- C It creates a region of higher pressure inside, pulling it to the wall
- D Gravity presses it onto the wall
- E It works even in perfect vacuum equally well

► **Explanation:** A suction cup reduces the air pressure inside (below atmospheric). The larger external atmospheric pressure then presses it firmly against the wall. In a vacuum, this effect largely disappears.

60 Water boils at a lower temperature on a high mountain mainly because:





- A Water's density decreases with altitude
- B Atmospheric pressure is lower, so boiling occurs when vapor pressure reaches a lower external pressure ✓**
- C Gravity is much stronger at altitude
- D Water becomes a different chemical at altitude
- E Surface tension becomes zero

► **Explanation:** Boiling happens when vapor pressure equals external pressure. Lower atmospheric pressure at altitude means this condition is met at a lower temperature.

**61** In a closed syringe filled with water (no air), if you push the plunger slightly inward, the pressure in the water:



- A Increases only near the plunger
- B Increases everywhere throughout the water almost equally ✓**
- C Decreases everywhere
- D Stays the same because water is incompressible
- E Becomes zero

► **Explanation:** Pascal's principle: a pressure change applied to an enclosed fluid is transmitted throughout the fluid. "Incompressible" means volume changes are small, not that pressure cannot change.

**62** A large stone is lowered slowly into a bucket full of water. Water spills over the edge. The spilled water volume equals:



- A The stone's mass
- B The stone's weight**





- C** The volume of water displaced (approximately the submerged volume of the stone)
- D** The bucket's volume
- E** Zero because water is incompressible

► **Explanation:** Immersing the stone displaces water equal to the submerged volume. If the bucket is already full, that displaced volume spills out.

**63** A floating object is pushed down so it is fully submerged and then released. What happens immediately after release (assuming it's less dense than the fluid)?



- A** It stays where it is because buoyancy is the same as weight
- B** It accelerates upward because buoyant force exceeds its weight when fully submerged
- C** It accelerates downward because pressure is higher below
- D** It becomes neutrally buoyant automatically
- E** It sinks because the fluid has entered it

► **Explanation:** A low-density object floats because when partially submerged, buoyant force matches weight. If forced fully underwater, it displaces more fluid, increasing buoyant force above its weight, giving a net upward force.

**64** An object is neutrally buoyant in water. This means:



- A** It experiences no forces at all
- B** Its density equals the density of water, so buoyant force equals its weight when fully submerged
- C** Its mass is zero
- D** It must float partially above the surface





- E Pressure is the same above and below it

► **Explanation:** Neutral buoyancy means buoyant force equals weight while fully submerged, so it neither rises nor sinks. That corresponds to equal densities (for an incompressible object).

**65** A stone is dropped into a river and sinks. Which statement about the buoyant force is correct?



- A Buoyant force is zero because it sinks
- B Buoyant force acts upward but is smaller than the stone's weight ✓**
- C Buoyant force acts downward when objects sink
- D Buoyant force equals the stone's weight, but the stone sinks anyway
- E Buoyant force depends only on the stone's weight

► **Explanation:** Buoyancy always acts upward in a fluid. The stone sinks because its weight exceeds the buoyant force (upthrust), not because buoyancy disappears.

**66** A hydrometer is used to measure fluid density by floating at different depths. It floats higher in a denser liquid because:



- A Denser liquids have less buoyant force
- B Denser liquids provide more buoyant force per displaced volume, so less volume needs to be submerged to balance weight ✓**
- C Pressure is lower in denser liquids
- D The hydrometer becomes lighter in dense liquids
- E Denser liquids always push objects downward

► **Explanation:**  $U_{\text{p thrust}} = \rho V_{\text{sub}} g$ . In a denser liquid, smaller submerged volume is needed for the buoyant force to equal the hydrometer's weight, so it floats higher.





**67** A U-tube contains water in one arm and oil in the other, and the two liquids do not mix. If the oil is less dense than water, then at the same horizontal level where both sides contain liquid, the pressure:



- A Is higher on the oil side
- B Is higher on the water side
- C **Must be equal on both sides (hydrostatic equilibrium)** ✓
- D Is zero on both sides
- E Depends on which side has more volume

► **Explanation:** In connected fluids at rest, pressure at the same horizontal level must match; otherwise fluid would flow. Different densities mean different column heights above that level, not different pressures at the same level.

**68** In a static fluid, why does pressure increase with depth?



- A Because deeper fluid molecules move faster
- B **Because the weight of fluid above must be supported by pressure differences** ✓
- C Because atmospheric pressure increases underwater
- D Because gravity decreases with depth so pressure must compensate
- E Because deeper parts have less volume

► **Explanation:** The pressure gradient with depth exists so that the upward pressure force balances the weight of the fluid above. It's a static equilibrium requirement, not a speed effect.





**69** A container of water is in free fall (e.g., dropped). Neglecting air resistance, inside the freely falling container the effective buoyant force on a small submerged object tends to:

- A Increase dramatically
- B Stay exactly the same as normal
- C Decrease toward zero, because the pressure gradient associated with gravity is effectively removed in the falling frame ✓**
- D Reverse direction and push downward
- E Become infinite

► **Explanation:** Buoyancy comes from a pressure difference caused by gravity (pressure increases with depth). In free fall, water and object accelerate together; in the falling frame, the effective gravity is near zero, so the hydrostatic pressure gradient (and thus buoyant effect) largely disappears.



**70** A siphon can move water from a higher container to a lower container over a hump because:

- A Water is pulled over the hump by suction alone
- B Gravity acting on the descending side creates lower pressure at the top and atmospheric pressure helps push liquid up the rising side, as long as the outlet is lower than the source surface ✓**
- C Water flows from low pressure to high pressure naturally
- D Siphons work only in vacuum
- E A siphon violates energy conservation

► **Explanation:** A siphon is driven by gravity and pressure differences: the longer descending column pulls, lowering pressure near the top; atmospheric pressure and continuity help maintain flow, provided the outlet is lower than the source surface and the top isn't too high for atmospheric pressure to support.





**71 Cavitation in a fast-moving propeller occurs when:**

- A Pressure becomes high enough to freeze water
- B Local pressure drops low enough that water can vaporize, forming bubbles ✓**
- C Density becomes negative
- D Water speed becomes zero everywhere
- E Buoyancy reverses direction

► **Explanation:** At high speeds, local pressure can drop (Bernoulli). If pressure drops below vapor pressure, bubbles form. Their collapse can damage surfaces—this is cavitation.



**72 At a high mountain, the mercury barometer height is smaller than at sea level mainly because:**

- A Mercury density decreases at altitude
- B Atmospheric pressure is lower, so it supports a shorter mercury column ✓**
- C Gravity becomes zero
- D Vacuum pressure increases
- E Mercury evaporates faster

► **Explanation:** Barometer height reflects atmospheric pressure: lower atmospheric pressure means less support for the mercury column, so the column height falls.



**73 In a static fluid, pressure forces on a solid surface act:**

- A Parallel to the surface (tangential)
- B Perpendicular (normal) to the surface ✓**





- C Always upward
- D Always toward the center of the container
- E Only along the direction of gravity

► **Explanation:** Pressure is a normal stress: it acts perpendicular to surfaces. Tangential forces are associated with viscosity (shear), not static pressure.

**74** A cube of side length  $L$  is fully submerged in water. The pressure at the bottom face is greater than at the top face. The buoyant force is the net result of:



- A Equal pressures cancelling in all directions
- B Greater upward pressure force on the bottom than the downward pressure force on the top ✓
- C Gravity pushing the cube upward
- D Water friction pulling the cube upward
- E Atmospheric pressure acting only on the bottom face

► **Explanation:** Pressure increases with depth, so the bottom face experiences a larger upward force ( $P_{\text{bottom}} \cdot A$ ) than the top face's downward force ( $P_{\text{top}} \cdot A$ ). This difference gives the buoyant force.

**75** A floating ship enters a lock where the water level is raised while the ship remains floating freely. As the water level rises, the buoyant force on the ship:



- A Increases because pressure is higher
- B Decreases because pressure is higher
- C Stays equal to the ship's weight (so it remains essentially unchanged) ✓
- D Becomes zero because the ship is now higher
- E Depends only on the lock's width





► **Explanation:** A freely floating object has buoyant force equal to its weight (equilibrium). As the lock fills, the ship rises with the water, adjusting displaced volume so upthrust continues to match weight.

