

Mechanical Properties of Fluids — CBSE Pattern Test 1

Class 11 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 1 — CBSE Pattern (90 minutes, 40 marks)

Class 11 Physics · Mechanical Properties of Fluids · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- The SI unit of pressure is
 - pascal
 - newton
 - joule
 - watt
- The pressure at a depth h in a liquid of density ρ is
 - $P_0 + \rho gh$
 - $P_0 - \rho gh$
 - ρgh alone
 - $P_0 \rho gh$
- The pressure at a point inside a liquid at rest
 - acts equally in all directions
 - acts only downwards
 - acts only on the bottom
 - depends on the direction
- Gauge pressure is
 - pressure above atmospheric pressure
 - total absolute pressure
 - pressure below atmospheric pressure
 - the pressure at sea level
- Pascal's law is valid for
 - a fluid at rest
 - a fluid in motion
 - only gases
 - only solids
- A hydraulic lift multiplies force in proportion to the
 - ratio of the piston areas
 - ratio of the piston diameters
 - density of the liquid
 - height of the liquid
- Hydraulic machines work because liquids are
 - practically incompressible

- (B) highly compressible
 - (C) less dense than solids
 - (D) good conductors of heat
8. If the area of the output piston is five times that of the input piston, a force of 50 N produces an output force of
- (A) 250 N
 - (B) 50 N
 - (C) 10 N
 - (D) 500 N
9. State Archimedes' principle.
10. State Stokes' law.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. Find the pressure at a depth of 10 m below the surface of water. ($\rho = 1000 \text{ kg m}^{-3}$, $g = 10 \text{ m/s}^2$, atmospheric pressure = 10^5 Pa)
12. A body of volume $2 \times 10^{-3} \text{ m}^3$ is fully immersed in water. Find the buoyant force on it. ($\rho = 1000 \text{ kg m}^{-3}$, $g = 10 \text{ m/s}^2$)
13. Water flows in a pipe of area 40 cm^2 at 2 m/s. Find the speed in a section of the pipe of area 10 cm^2 .
14. A submarine is at a depth of 20 m in water of density 1000 kg/m^3 . Find the pressure on it. ($g = 10 \text{ m/s}^2$, $P_0 = 10^5 \text{ Pa}$)

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. A rectangular tank is filled with water up to a height of 2 m. Find the total force on a wall of dimensions $2 \text{ m} \times 3 \text{ m}$ due to the water. ($\rho = 1000 \text{ kg m}^{-3}$, $g = 10 \text{ m/s}^2$)
16. The small piston of a hydraulic press has a diameter of 2 cm and the large piston a diameter of 20 cm. If a force of 10 N is applied to the small piston, find the force on the large piston.
17. A cube of side 5 cm floats in water with 60% of its volume submerged. Find the density of the cube. ($\rho_{\text{water}} = 1000 \text{ kg m}^{-3}$)
18. Water rises to 4 cm in a capillary tube of radius 0.5 mm. Find the surface tension of water. ($\rho = 1000 \text{ kg m}^{-3}$, $\cos\theta \approx 1$, $g = 10 \text{ m/s}^2$)

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Derive the equation of continuity and Bernoulli's equation, and explain with the help of a diagram how the venturi meter and the atomizer work on Bernoulli's principle.
20. Describe the phenomenon of capillarity, derive the expression for the height of a liquid column in a capillary tube, and explain its dependence on radius and angle of contact.

Answer Key (Marking Scheme)

- Q1 — (A) pascal. Q2 — (A) $P_0 + \rho gh$. Q3 — (A) equally in all directions. Q4 — (A) pressure above atmospheric pressure.
- Q5 — (A) a fluid at rest. Q6 — (A) ratio of the piston areas. Q7 — (A) practically incompressible. Q8 — (A) 250 N.
- Q9 — The buoyant force on a body immersed in a fluid equals the weight of the displaced fluid.
- Q10 — For a sphere falling through a viscous fluid, the viscous drag is $F = 6\pi\eta rv$.
- Q11 — $P = 10^5 + 1000 \times 10 \times 10 = 2 \times 10^5 \text{ Pa}$.

Q12 — $F_b = \rho g V = 1000 \times 10 \times 2 \times 10^{-3} = 20 \text{ N}$.

Q13 — $v_2 = v_1 A_1 / A_2 = 2 \times 40 / 10 = 8 \text{ m/s}$.

Q14 — $P = P_0 + \rho g h = 10^5 + 1000 \times 10 \times 20 = 3 \times 10^5 \text{ Pa}$.

Q15 — Mean pressure = $\frac{1}{2} \rho g H = 10^4 \text{ Pa}$; $F = 10^4 \times 6 = 6 \times 10^4 \text{ N}$.

Q16 — $(D_2/D_1)^2 = 100 \Rightarrow D_2 = 10 \times 100 = 1000 \text{ N}$.

Q17 — $\rho_{\text{cube}} = 0.6 \times 1000 = 600 \text{ kg m}^{-3}$.

Q18 — $T = h \rho g r / 2 = 0.04 \times 1000 \times 10 \times 5 \times 10^{-4} / 2 = 0.1 \text{ N m}^{-1}$.

Q19 — $A_1 v_1 = A_2 v_2$ (continuity); $P + \frac{1}{2} \rho v^2 + \rho g h = \text{constant}$. Venturi: pressure falls where the tube narrows; atomizer: fast air stream lowers pressure and draws the liquid up the tube.

Q20 — $h = 2T \cos \theta / (r \rho g)$: rise is inversely proportional to the radius and depends on the angle of contact through $\cos \theta$.