Mechanical Properties of Fluids

Class 11 Physics · 24 NEET MCQs with answers & explanations

Mechanical Properties of Fluids covers pressure, Pascal's law, Archimedes' principle, Bernoulli's theorem, viscosity, Stokes' law, surface tension and capillarity. NEET tests Bernoulli's equation application, buoyancy problems, surface tension and viscosity — a mix of conceptual and numerical questions.

Key Fluid Concepts

Concept	Key Fact
Pascal's law	Pressure applied to enclosed fluid is transmitted equally in all directions
Archimedes' principle	Buoyant force = weight of displaced fluid; floats if ρ_body < ρ_fluid
Bernoulli's theorem	$P + \frac{1}{2}\rho v^2 + \rho g h$ = constant along a streamline
Stokes' law	$F = 6\pi\eta r v$; terminal velocity $v_t = 2r^2(\rho-\sigma)g/9\eta$
Surface tension	$T = F/L$; excess pressure: sphere = 2T/R, bubble = 4T/R (two surfaces)
Capillarity	$h = 2T\cos\theta / \rho g r$; rises in narrow tube if $\theta < 90°$ (water in glass)

Questions

Q1. A liquid exerts pressure at a point primarily because of:

(A) Random molecular collisions only
(B) Atmospheric pressure acting downward alone
(C) The weight of the liquid column above that point
(D) Its weight acting on the container walls only

Q2. The SI unit of pressure is Pascal (Pa). Which of the following correctly expresses 1 Pa in SI base units?

(A) 1 kg m^{-1} s^{-2}
(B) 1 N m
(C) 1 J m
(D) 1 kg m s^{-2}

Q3. Flow in which every fluid particle follows a definite smooth path and no two paths intersect is called:

(A) Turbulent flow
(B) Rotational flow
(C) Viscous flow
(D) Streamline (laminar) flow

Q4. The SI unit of volume flow rate (discharge) is:

(A) m^2 s^{-1}
(B) m s^{-1}
(C) m^3 s^{-1}
(D) m^3

Q5. Flow in which fluid particles move in smooth parallel layers without mixing with adjacent layers is called:

(A) Laminar (streamline) flow
(B) Turbulent flow
(C) Compressible flow
(D) Rotational flow

Q6. Reynolds number is best described as:

(A) A physical force that drives fluid flow
(B) A unit used to measure viscosity
(C) A dimensionless quantity that predicts the nature of fluid flow
(D) A measure of fluid pressure at the pipe wall

Q7. The angle of contact is the angle between the tangent to the liquid surface at the point of contact and the solid surface, measured through the:

(A) Air above the liquid
(B) Liquid
(C) Solid material
(D) Vacuum surrounding the system

Q8. For pure water in a clean glass tube, the angle of contact is approximately:

(A) 180°
(B) 90°
(C) 0°
(D) 45°

Q9. Viscosity is the property of a fluid by virtue of which it resists:

(A) Change in temperature
(B) Compression
(C) Relative motion between its adjacent layers
(D) Change in volume

Q10. The SI unit of coefficient of viscosity η is:

(A) N s
(B) N m^{-1}
(C) Pa·s (Pascal-second)
(D) kg m^{-2}

Q11. Stokes' law is valid only when the Reynolds number of the flow around the sphere is:

(A) Greater than 2000
(B) Between 1000 and 2000
(C) Between 100 and 1000
(D) Much less than 1 (Re << 1)

Q12. The SI unit of the coefficient of viscosity η appearing in Stokes' law F = 6πηrv is:

(A) N
(B) kg
(C) kg m^{-1} s^{-1} (Pa·s)
(D) N m^{-2}

Q13. Surface tension is defined as the force acting per unit:

(A) Length along the liquid surface
(B) Area of the liquid surface
(C) Volume of the liquid
(D) Mass of the liquid

Q14. When a glass surface is in contact with water, the angle of contact is acute (less than 90°). Which of the following correctly explains this?

(A) Cohesive force between water molecules exceeds adhesive force between water and glass
(B) Adhesive force between water and glass exceeds cohesive force between water molecules
(C) Water and glass have the same density
(D) Surface tension of water is zero at room temperature

Q15. Bernoulli's theorem is based on conservation of:

(A) Momentum
(B) Angular momentum
(C) Mechanical energy
(D) Mass

Q16. One essential assumption for Bernoulli's equation to be valid is that the fluid must be:

(A) Non-viscous (ideal)
(B) Compressible
(C) Rotating rapidly
(D) Highly viscous

Q17. The excess pressure inside a liquid drop of radius R and surface tension T is:

(A) 2T/R
(B) T/R
(C) 4T/R
(D) 8T/R

Q18. The excess pressure inside a soap bubble of radius R and surface tension T is:

(A) T/R
(B) 2T/R
(C) 3T/R
(D) 4T/R

Q19. A Venturimeter is primarily used to measure:

(A) Pressure difference between two points
(B) Rate of flow of a fluid
(C) Coefficient of viscosity of the fluid
(D) Surface tension of the fluid

Q20. A soap bubble has radius 2 cm and surface tension 0.04 N m^{-1}. The excess pressure inside the bubble is:

(A) 8 Pa
(B) 4 Pa
(C) 16 Pa
(D) 2 Pa

Q21. An ideal fluid is assumed to be:

(A) Incompressible and non-viscous
(B) Compressible and non-viscous
(C) Incompressible and viscous
(D) Compressible and viscous

Q22. Bernoulli's equation is valid only:

(A) For turbulent flow
(B) For every real fluid
(C) Along a streamline under steady, non-viscous, incompressible flow
(D) Only for gases

Q23. The hydrostatic pressure at depth h in a liquid of density ρ is P = ρgh. If depth is doubled and density is halved, the new pressure is:

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

Q24. In a static liquid, pressure at all points on the same horizontal level is equal. If pressure were different at two points on the same horizontal level, what would happen?

(A) The liquid would flow until pressure equalises
(B) Density of the liquid would change to compensate
(C) Pressure would increase on the low-pressure side
(D) Temperature of the liquid would rise

Answer key

1-C	2-A	3-D	4-C	5-A	6-C	7-B	8-C
9-C	10-C	11-D	12-C	13-A	14-B	15-C	16-A
17-A	18-D	19-B	20-A	21-A	22-C	23-D	24-A

Answers with explanations

Q1 — Answer: (C) The weight of the liquid column above that point
Hydrostatic pressure arises from the weight of the liquid above the point, given by P = ρgh. Molecular collisions cause gas pressure, not hydrostatic pressure. Atmospheric pressure is external and separate.

Q2 — Answer: (A) 1 kg m^{-1} s^{-2}
Pa = N m^{-2} = (kg m s^{-2}) m^{-2} = kg m^{-1} s^{-2}. Option D is the unit of force (Newton), not pressure. Options B and C are dimensionally incorrect for pressure.

Q3 — Answer: (D) Streamline (laminar) flow
In streamline flow, each fluid particle follows a fixed smooth path called a streamline. Paths never intersect because velocity at every point is unique. Turbulent flow has irregular, crossing paths with eddies.

Q4 — Answer: (C) $m^3 s^{-1}$
Volume flow rate Q = Av has dimensions $[m^2][m\ s^{-1}] = m^3\ s^{-1}$. Option A ($m^2\ s^{-1}$) is the unit of kinematic viscosity — a common confusion. Option B is speed, not flow rate.

Q5 — Answer: (A) Laminar (streamline) flow
Laminar flow has smooth parallel layers where particles follow definite paths without mixing. It occurs at low Reynolds numbers (Re < 2000). Turbulent flow, not laminar, involves mixing and eddies.

Q6 — Answer: (C) A dimensionless quantity that predicts the nature of fluid flow
Re = ρvD/η is dimensionless — no units or dimensions. It predicts laminar, transitional, or turbulent flow. Option A is wrong; Re is a ratio of forces, not a force itself.

Q7 — Answer: (B) Liquid
The angle of contact is always measured through the liquid — between the tangent to the liquid surface at the contact point and the solid surface. Measuring through air or solid gives a different and physically meaningless angle.

Q8 — Answer: (C) 0°
Water strongly wets clean glass because adhesive forces between water and glass exceed cohesive forces within water. This produces a nearly zero angle of contact and a strongly concave meniscus.

Q9 — Answer: (C) Relative motion between its adjacent layers
Viscosity is the internal friction between adjacent fluid layers that opposes their relative sliding motion. It is not related to compression, volume change, or temperature change directly.

Q10 — Answer: (C) Pa·s (Pascal-second)
The SI unit of η is Pascal-second (Pa·s), equivalent to $kg\ m^{-1}\ s^{-1}$. N s is the unit of impulse (momentum), not viscosity — a common confusion in unit-based questions.

Q11 — Answer: (D) Much less than 1 (Re << 1)
Stokes' law assumes creeping (laminar) flow where inertial forces are negligible. This requires Re << 1. At higher Re, inertial effects become significant and Stokes' law breaks down.

Q12 — Answer: (C) $kg\ m^{-1}\ s^{-1}$ (Pa·s)
From $F = 6\pi\eta rv$, $\eta = F/(6\pi rv)$. Units: $N/(m \times m\ s^{-1}) = N\ m^{-2}\ s = Pa{\cdot}s = kg\ m^{-1}\ s^{-1}$. Option D ($N\ m^{-2}$) is the unit of pressure, not viscosity — a common confusion.

Q13 — Answer: (A) Length along the liquid surface
Surface tension T = F/l is the tangential force per unit length along an imaginary line on the free surface. Its SI unit is $N\ m^{-1}$, equivalent to $J\ m^{-2}$.

Q14 — Answer: (B) Adhesive force between water and glass exceeds cohesive force between water molecules
When adhesive force (water-glass) exceeds cohesive force (water-water), water wets glass and the meniscus is concave — angle of contact is acute. For mercury on glass the reverse holds, giving obtuse angle.

Q15 — Answer: (C) Mechanical energy
Bernoulli's equation is derived by applying conservation of mechanical energy to a steady, incompressible, non-viscous fluid along a streamline. Momentum and mass conservation are separate principles.

Q16 — Answer: (A) Non-viscous (ideal)
Bernoulli's theorem requires the fluid to be ideal: non-viscous, incompressible, in steady streamline flow. Viscosity causes energy dissipation, directly violating the constant-energy condition.

Q17 — Answer: (A) 2T/R
A liquid drop has one free surface. Young-Laplace equation gives ΔP = 2T/R. Option C (4T/R) is the soap bubble formula — a common substitution error.

Q18 — Answer: (D) 4T/R
A soap bubble has two free surfaces. Surface tension acts on both, giving ΔP = 2 × (2T/R) = 4T/R. Option B is the liquid drop formula — the most common error.

Q19 — Answer: (B) Rate of flow of a fluid
A Venturimeter applies Bernoulli's theorem and continuity equation. The pressure difference between the wide and narrow sections is used to calculate volumetric discharge. Pressure difference is a means, not the end measurement.

Q20 — Answer: (A) 8 Pa
A soap bubble has two free surfaces, so ΔP = 4T/R = (4 × 0.04)/0.02 = 8 Pa. Option C arises from mistakenly using ΔP = 8T/R; Option B from using 2T/R (valid for a drop, not a bubble).

Q21 — Answer: (A) Incompressible and non-viscous
NCERT defines ideal fluid as incompressible and non-viscous; these assumptions underlie Bernoulli's equation derivation. Compressible or viscous fluids require different equations of motion.

Q22 — Answer: (C) Along a streamline under steady, non-viscous, incompressible flow
Bernoulli's theorem applies along a streamline for steady, incompressible, non-viscous flow. Turbulent flow and real viscous fluids violate these assumptions.

Q23 — Answer: (D) P
New pressure = (ρ/2) × g × (2h) = ρgh = P. Doubling depth and halving density cancel exactly. A common error is to add effects rather than multiply, giving 2P incorrectly.

Q24 — Answer: (A) The liquid would flow until pressure equalises
A pressure difference at the same horizontal level drives fluid flow. The fluid accelerates toward the low-pressure region until hydrostatic equilibrium is restored. Density and temperature changes do not compensate for pressure differences in incompressible fluids.

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