Fluid Mechanics MCQ Questions and Answers

100 questions in 10 topics, with an answer key and a short explanation for every answer. Useful for university exams, GATE practice, viva and interviews.

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How to use: attempt one topic at a time without looking at the answers, then check the answer key at the end and read the explanation for every mistake.
Topics: 1. Fluid Properties · 2. Pressure and Manometers · 3. Hydrostatic Forces and Buoyancy · 4. Fluid Kinematics · 5. Bernoulli and Momentum Equations · 6. Flow Measurement · 7. Flow Through Pipes · 8. Laminar Flow and Boundary Layer · 9. Dimensional Analysis and Similitude · 10. Pumps and Turbines

1. Fluid Properties

Q1. A fluid is a substance that:
(a) Deforms continuously under any shear stress, however small
(b) Cannot resist any normal stress
(c) Has no viscosity
(d) Always has constant density

Q2. The SI unit of dynamic viscosity is:
(a) m^2/s
(b) Pa·s
(c) N/m
(d) kg/m^3

Q3. Kinematic viscosity is defined as:
(a) $\mu \times \rho$
(b) ρ / μ
(c) μ / ρ
(d) τ / μ

Q4. The SI unit of kinematic viscosity is:
(a) Poise
(b) Pa·s
(c) N·s/m
(d) m^2/s

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Q5. As temperature increases, the viscosity of a liquid:
(a) Decreases
(b) Increases
(c) Stays the same
(d) First increases, then decreases

Q6. As temperature increases, the viscosity of a gas:
(a) Decreases
(b) Increases
(c) Stays the same
(d) Becomes zero

Q7. A fluid whose shear stress is directly proportional to the velocity gradient is called:
(a) Ideal fluid
(b) Non-Newtonian fluid
(c) Newtonian fluid
(d) Bingham plastic

Q8. An ideal fluid is one that is:
(a) Viscous and compressible
(b) Non-viscous and compressible
(c) Viscous and incompressible
(d) Non-viscous and incompressible

Q9. The specific gravity of a liquid is 0.8. Its density is:
(a) 800 kg/m³
(b) 80 kg/m³
(c) 8000 kg/m³
(d) 0.8 kg/m³

Q10. Surface tension has the unit:
(a) N/m²
(b) N/m
(c) N·m
(d) N

2. Pressure and Manometers

Q11. Pressure at a depth h in a liquid of density ρ (gauge) is:
(a) ρg/h
(b) ρh/g
(c) ρgh
(d) gh/ρ

Q12. Pascal's law states that pressure at a point in a fluid at rest is:
(a) Greater in the vertical direction
(b) Proportional to velocity
(c) Zero at the surface only
(d) Equal in all directions

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Q13. Absolute pressure is equal to:
(a) Gauge pressure + atmospheric pressure
(b) Gauge pressure − atmospheric pressure
(c) Atmospheric pressure − vacuum pressure × 2
(d) Gauge pressure only

Q14. Standard atmospheric pressure is approximately:
(a) 10.13 kPa
(b) 101.3 kPa
(c) 1013 kPa
(d) 1.013 kPa

Q15. Atmospheric pressure is measured by a:
(a) Manometer
(b) Pitot tube
(c) Barometer
(d) Venturimeter

Q16. A simple U-tube manometer measures:
(a) Velocity
(b) Discharge
(c) Viscosity
(d) Pressure

Q17. A differential manometer is used to measure:
(a) Pressure difference between two points
(b) Pressure at one point
(c) Atmospheric pressure
(d) Surface tension

Q18. A pressure head of 10 m of water is roughly equal to:
(a) 9.81 kPa
(b) 98.1 kPa
(c) 981 kPa
(d) 0.981 kPa

Q19. A Bourdon tube gauge measures:
(a) Absolute pressure
(b) Vacuum only
(c) Gauge pressure
(d) Dynamic pressure only

Q20. Mercury is commonly used in manometers mainly because:
(a) It is cheap
(b) It wets glass well
(c) It is transparent
(d) It has high density and low vapour pressure

3. Hydrostatic Forces and Buoyancy

Q21. The total pressure force on a plane surface immersed in a liquid is:
(a) ρgAh̄
(b) ρgA
(c) ρgh̄
(d) ρAh̄

Q22. The centre of pressure on a vertical plane surface lies:
(a) Above the centroid
(b) Below the centroid
(c) At the centroid
(d) At the free surface

Q23. As the depth of immersion of a vertical plate increases, the centre of pressure:
(a) Moves away from the centroid
(b) Stays at the same distance
(c) Comes closer to the centroid
(d) Moves to the free surface

Q24. The buoyant force on a body equals:
(a) Weight of the body
(b) Density of the fluid
(c) Volume of the body
(d) Weight of the fluid displaced

Q25. The centre of buoyancy is the:
(a) Centroid of the displaced volume
(b) Centre of gravity of the body
(c) Metacentre
(d) Centre of pressure

Q26. A floating body is in stable equilibrium when the metacentre is:
(a) Below the centre of gravity
(b) Above the centre of gravity
(c) At the centre of gravity
(d) At the centre of buoyancy

Q27. Metacentric height is the distance between:
(a) Centre of buoyancy and centre of gravity
(b) Metacentre and centre of buoyancy
(c) Metacentre and centre of gravity
(d) Centre of gravity and free surface

Q28. A ship with a very large metacentric height will:
(a) Roll slowly
(b) Sink
(c) Not float
(d) Roll quickly and feel uncomfortable

Q29. For a fully submerged body to be stable, the centre of buoyancy must be:
(a) Above the centre of gravity
(b) Below the centre of gravity
(c) At the same point as G
(d) At the free surface

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Q30. The horizontal component of force on a curved submerged surface equals:
(a) Weight of liquid above the surface
(b) Force on the vertical projection of the surface
(c) Zero
(d) Buoyant force

4. Fluid Kinematics

Q31. A flow in which velocity at a point does not change with time is:
(a) Uniform flow
(b) Laminar flow
(c) Steady flow
(d) Rotational flow

Q32. A flow in which velocity does not change from point to point along the flow at a given instant is:
(a) Steady flow
(b) Compressible flow
(c) Turbulent flow
(d) Uniform flow

Q33. The continuity equation is based on conservation of:
(a) Mass
(b) Momentum
(c) Energy
(d) Angular momentum

Q34. Water flows through a pipe that narrows from 0.2 m^2 to 0.1 m^2. If inlet velocity is 2 m/s, outlet velocity is:
(a) 1 m/s
(b) 4 m/s
(c) 2 m/s
(d) 8 m/s

Q35. A line tangent to the velocity vector at every point at an instant is a:
(a) Pathline
(b) Streakline
(c) Streamline
(d) Timeline

Q36. In steady flow, streamlines, pathlines and streaklines are:
(a) Always different
(b) Undefined
(c) Perpendicular
(d) Identical

Q37. Flow in which fluid particles do not rotate about their own axes is called:
(a) Irrotational flow
(b) Rotational flow
(c) Turbulent flow
(d) Viscous flow

Q38. The stream function exists for:
(a) Only irrotational flows
(b) Two-dimensional incompressible flows that satisfy continuity
(c) Only compressible flows
(d) Only 3-D flows

Q39. The velocity potential function exists only for:
(a) Rotational flow
(b) Viscous flow
(c) Irrotational flow
(d) Unsteady flow

Q40. Lines of constant stream function and lines of constant velocity potential are:
(a) Parallel
(b) Identical
(c) At 45°
(d) Perpendicular to each other

5. Bernoulli and Momentum Equations

Q41. Bernoulli's equation is derived from:
(a) Euler's equation of motion along a streamline
(b) Conservation of mass
(c) Newton's law of viscosity
(d) First law of thermodynamics only

Q42. Bernoulli's equation in head form is:
(a) $p + V + z = \text{constant}$
(b) $p/\rho g + V^2/2g + z = \text{constant}$
(c) $pV = \text{constant}$
(d) $\rho V^2/2 = \text{constant}$

Q43. Which is NOT an assumption of Bernoulli's equation?
(a) Steady flow
(b) Incompressible flow
(c) Turbulent flow
(d) Non-viscous flow

Q44. Velocity head is expressed as:
(a) $V/2g$
(b) V^2/g
(c) $2gV$
(d) $V^2/2g$

Q45. Water leaves a tank through a small hole 5 m below the free surface. Ideal jet velocity is about:
(a) 9.9 m/s
(b) 5 m/s
(c) 49 m/s
(d) 3.1 m/s

Q46. The momentum equation is based on:
(a) Conservation of mass
(b) Newton's second law
(c) Conservation of energy
(d) Pascal's law

Q47. A water jet of area 0.002 m² and velocity 10 m/s strikes a fixed flat plate normally. Force on the plate is:
(a) 20 N
(b) 2000 N
(c) 200 N
(d) 100 N

Q48. The kinetic energy correction factor for fully developed laminar flow in a pipe is:
(a) 1.0
(b) 1.33
(c) 1.05
(d) 2.0

Q49. Hydraulic grade line lies below the energy grade line by:
(a) Velocity head
(b) Pressure head
(c) Datum head
(d) Loss of head

Q50. Euler's equation of motion considers:
(a) Pressure, gravity and viscous forces
(b) Pressure and gravity forces only
(c) Viscous forces only
(d) Surface tension only

6. Flow Measurement

Q51. A venturimeter is used to measure:
(a) Velocity at a point
(b) Pressure at a point
(c) Discharge through a pipe
(d) Viscosity

Q52. The coefficient of discharge of a venturimeter is typically:
(a) 0.60–0.65
(b) 1.2–1.5
(c) 0.30–0.40
(d) 0.95–0.99

Q53. The coefficient of discharge of an orifice meter is typically:
(a) 0.60–0.65
(b) 0.95–0.99
(c) 1.0
(d) 0.2

Q54. Vena contracta is the section of a jet where:
(a) Velocity is minimum
(b) Area is minimum and velocity is maximum
(c) Area is maximum
(d) Pressure is maximum

Q55. Coefficient of discharge Cd is related to Cc and Cv by:
(a) Cd = Cc + Cv
(b) Cd = Cc / Cv
(c) Cd = Cc × Cv
(d) Cd = Cv − Cc

Q56. A pitot tube measures:
(a) Discharge
(b) Surface tension
(c) Viscosity
(d) Velocity at a point

Q57. A pitot-static tube shows a head difference of 0.2 m of water. The flow velocity is about:
(a) 1.98 m/s
(b) 0.44 m/s
(c) 3.92 m/s
(d) 19.6 m/s

Q58. A rotameter works on the principle of:
(a) Variable head with fixed area
(b) Variable area
(c) Momentum change
(d) Pitot effect

Q59. A notch or weir is used to measure discharge in:
(a) Closed pipes
(b) Pumps
(c) Open channels
(d) Nozzles

Q60. Discharge over a rectangular notch varies with head H as:
(a) H^0.5
(b) H
(c) H^2.5
(d) H^1.5

7. Flow Through Pipes

Q61. Flow in a circular pipe is usually laminar when Reynolds number is below about:
(a) 2000
(b) 200
(c) 4000
(d) 10^5

Q62. Reynolds number is the ratio of:
(a) Inertia force to gravity force
(b) Inertia force to viscous force
(c) Viscous force to pressure force
(d) Pressure force to inertia force

Q63. The Darcy–Weisbach equation for head loss is:
(a) $h_f = 4fL/D$
(b) $h_f = fLV/(2gD)$
(c) $h_f = fLV^2/(2gD)$
(d) $h_f = fV^2/2g$

Q64. For laminar flow in a pipe, the Darcy friction factor is:
(a) 16/Re
(b) Constant
(c) 0.316/Re^0.25
(d) 64/Re

Q65. The Moody chart gives the friction factor as a function of:
(a) Re and relative roughness
(b) Relative roughness only
(c) Re only
(d) Velocity and length

Q66. The loss of head due to sudden enlargement is:
(a) $V_1^2/2g$
(b) $(V_1 - V_2)^2/2g$
(c) $0.5\ V_2^2/2g$
(d) $(V_1 + V_2)^2/2g$

Q67. Loss of head at the entrance of a pipe from a large tank (sharp edge) is about:
(a) $V^2/2g$
(b) $2\ V^2/2g$
(c) $0.5\ V^2/2g$
(d) Zero

Q68. Loss of head at the exit of a pipe into a large tank is:
(a) $0.5\ V^2/2g$
(b) $2\ V^2/2g$
(c) Zero
(d) $V^2/2g$

Q69. When pipes are connected in series, the total head loss is:
(a) The sum of losses in each pipe
(b) The same in each pipe
(c) The loss in the largest pipe
(d) Zero

Q70. When pipes are connected in parallel:
(a) Discharge is the same in each pipe
(b) Head loss is the same in each branch
(c) Velocity is the same in each pipe
(d) Diameter must be the same

8. Laminar Flow and Boundary Layer

Q71. In fully developed laminar flow in a circular pipe, the velocity profile is:
(a) Linear
(b) Logarithmic
(c) Parabolic
(d) Uniform

Q72. In laminar pipe flow, maximum velocity at the centre equals:
(a) Average velocity
(b) 1.5 × average velocity
(c) 0.5 × average velocity
(d) 2 × average velocity

Q73. In laminar pipe flow, shear stress across the section varies:
(a) Linearly – zero at centre, maximum at wall
(b) Parabolically
(c) Uniformly
(d) Logarithmically

Q74. The Hagen–Poiseuille equation gives the pressure drop in laminar pipe flow as:
(a) $64\mu VL/D$
(b) $32\mu VL/D^2$
(c) $fLV^2/2gD$
(d) $\mu V/D$

Q75. The boundary layer is the thin region near a wall where:
(a) Pressure is zero
(b) Flow is always turbulent
(c) Viscous effects are important
(d) Velocity is uniform

Q76. Boundary layer thickness is usually defined where velocity reaches:
(a) 50% of free-stream
(b) 90% of free-stream
(c) 100% of free-stream
(d) 99% of free-stream

Q77. For laminar flow over a flat plate, boundary layer thickness grows with x as:
(a) x^0.5
(b) x
(c) x^0.8
(d) x^2

Q78. Boundary layer separation occurs when:
(a) Pressure decreases in the flow direction
(b) Adverse pressure gradient is present and wall shear becomes zero
(c) Velocity is very high
(d) Flow is laminar

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Q79. On a flat plate, transition from laminar to turbulent boundary layer occurs at Re_x of about:
(a) 2000
(b) 10^3
(c) 5×10^5
(d) 10^9

Q80. Displacement thickness is the distance by which:
(a) The flow separates
(b) The plate bends
(c) The boundary layer is thickest
(d) The wall must be moved to keep the same flow rate in ideal flow

9. Dimensional Analysis and Similitude

Q81. Buckingham's π theorem states that if there are n variables and m fundamental dimensions, the number of π terms is:
(a) $n - m$
(b) $n + m$
(c) $n \times m$
(d) $m - n$

Q82. Froude number is the ratio of:
(a) Inertia force to viscous force
(b) Inertia force to gravity force
(c) Inertia force to elastic force
(d) Inertia force to surface tension force

Q83. Mach number is the ratio of:
(a) Pressure force to inertia force
(b) Inertia force to gravity force
(c) Flow velocity to speed of sound
(d) Viscous force to inertia force

Q84. Weber number is the ratio of inertia force to:
(a) Gravity force
(b) Viscous force
(c) Elastic force
(d) Surface tension force

Q85. Euler number is the ratio of:
(a) Pressure force to inertia force
(b) Gravity force to viscous force
(c) Elastic force to inertia force
(d) Inertia force to viscous force

Q86. Model testing of ships is mainly based on:
(a) Reynolds model law
(b) Froude model law
(c) Mach model law
(d) Weber model law

Q87. Model testing of flow through closed pipes is mainly based on:
(a) Froude model law
(b) Mach model law
(c) Reynolds model law
(d) Euler model law

Q88. Testing of aircraft at high speeds in wind tunnels is mainly based on:
(a) Euler model law
(b) Froude model law
(c) Weber model law
(d) Mach model law

Q89. Geometric similarity between model and prototype means:
(a) Same ratio of all corresponding lengths
(b) Same velocity ratio everywhere
(c) Same force ratio
(d) Same fluid

Q90. Under Froude similarity, the velocity scale ratio V_r equals:
(a) L_r
(b) $\sqrt{L_r}$
(c) L_r^2
(d) $1/L_r$

10. Pumps and Turbines

Q91. A Pelton wheel is a:
(a) Reaction turbine for low head
(b) Reaction turbine for medium head
(c) Impulse turbine for high head
(d) Axial-flow pump

Q92. A Kaplan turbine is suitable for:
(a) High head, low discharge
(b) Very high head only
(c) Medium head, medium discharge
(d) Low head, high discharge

Q93. A Francis turbine is a:
(a) Mixed-flow reaction turbine
(b) Pure impulse turbine
(c) Tangential-flow turbine
(d) Axial-flow impulse turbine

Q94. The draft tube in a reaction turbine is used to:
(a) Increase pressure at the inlet
(b) Recover kinetic energy and allow the turbine above tailrace level
(c) Reduce discharge
(d) Control speed

Q95. Specific speed of a turbine is defined using:
(a) N H / P
(b) N√Q / H^(3/4)
(c) N√P / H^(5/4)
(d) N P / H

Q96. Priming of a centrifugal pump means:
(a) Starting it at full speed
(b) Lubricating bearings
(c) Closing the delivery valve
(d) Filling the suction pipe and casing with liquid before starting

Q97. Cavitation in pumps and turbines is caused when local pressure falls below:
(a) Vapour pressure of the liquid
(b) Atmospheric pressure
(c) Delivery pressure
(d) Zero gauge

Q98. NPSH available must be:
(a) Less than NPSH required
(b) Greater than NPSH required
(c) Equal to zero
(d) Equal to delivery head

Q99. For a centrifugal pump, discharge varies with speed N as:
(a) N^3
(b) N^2
(c) N
(d) √N

Q100. A reciprocating pump is best suited for:
(a) High discharge, low head
(b) Slurries only
(c) Very large flow rates
(d) Low discharge, high head

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Answer Key with Explanations

1. Fluid Properties

Q1. (a) Deforms continuously under any shear stress, however small – A fluid keeps deforming as long as a shear stress acts on it. A solid deforms only by a fixed amount.

Q2. (b) Pa·s – Dynamic viscosity μ has the unit Pa·s (N·s/m²). m²/s is the unit of kinematic viscosity.

Q3. (c) μ / ρ – ν = μ/ρ, the ratio of dynamic viscosity to density.

Q4. (d) m²/s – ν = μ/ρ gives (N·s/m²)/(kg/m³) = m²/s. The CGS unit is the stoke.

Q5. (a) Decreases – Cohesive forces between liquid molecules weaken with temperature, so liquid viscosity falls.

Q6. (b) Increases – In gases viscosity comes from molecular momentum exchange, which grows with temperature.

Q7. (c) Newtonian fluid – Newton's law of viscosity, $\tau = \mu \, du/dy$, holds for Newtonian fluids such as water and air.

Q8. (d) Non-viscous and incompressible – An ideal fluid has zero viscosity and constant density. It is an assumption used to simplify analysis.

Q9. (a) 800 kg/m³ – Density = SG × density of water = 0.8 × 1000 = 800 kg/m³.

Q10. (b) N/m – Surface tension is force per unit length, so N/m (equivalently J/m²).

2. Pressure and Manometers

Q11. (c) ρgh – Hydrostatic gauge pressure p = ρgh.

Q12. (d) Equal in all directions – In a static fluid there is no shear, so pressure at a point acts equally in every direction.

Q13. (a) Gauge pressure + atmospheric pressure – p_abs = p_gauge + p_atm. For a vacuum reading, p_abs = p_atm − p_vacuum.

Q14. (b) 101.3 kPa – 1 atm = 101.325 kPa = 760 mm of mercury = about 10.33 m of water.

Q15. (c) Barometer – A barometer measures local atmospheric pressure.

Q16. (d) Pressure – A manometer balances a fluid column against the pressure being measured.

Q17. (a) Pressure difference between two points – It is connected to two points and reads the difference in pressure between them.

Q18. (b) 98.1 kPa – p = ρgh = 1000 × 9.81 × 10 = 98,100 Pa ≈ 98.1 kPa.

Q19. (c) Gauge pressure – A Bourdon gauge reads pressure relative to the surrounding atmosphere, which is gauge pressure.

Q20. (d) It has high density and low vapour pressure – High density keeps the column short, and low vapour pressure means little evaporation.

3. Hydrostatic Forces and Buoyancy

Q21. (a) ρgAħ – F = ρg A ħ, where ħ is the depth of the centroid of the surface.

Q22. (b) Below the centroid – h* = ħ + I_G/(A ħ), so the centre of pressure is always below the centroid.

Q23. (c) Comes closer to the centroid – The term I_G/(A ħ) becomes smaller as ħ increases, so the gap shrinks.

Q24. (d) Weight of the fluid displaced – Archimedes' principle: the upward thrust equals the weight of the displaced fluid.

Q25. (a) Centroid of the displaced volume – The buoyant force acts through the centroid of the displaced fluid volume.

Q26. (b) Above the centre of gravity – If M is above G, a small tilt creates a restoring couple. If M is below G, the body overturns.

Q27. (c) Metacentre and centre of gravity – GM = BM − BG; it is the distance from G to M.

Q28. (d) Roll quickly and feel uncomfortable – Large GM gives a short rolling period, so the ship is very stable but uncomfortable.

Q29. (a) Above the centre of gravity – For a submerged body (such as a submarine) B must lie above G.

Q30. (b) Force on the vertical projection of the surface – F_x equals the hydrostatic force on the projection of the curved surface on a vertical plane.

4. Fluid Kinematics

Q31. (c) Steady flow – Steady flow means $\partial V/\partial t = 0$ at every point.

Q32. (d) Uniform flow – Uniform flow means $\partial V/\partial s = 0$ along the flow direction.

Q33. (a) Mass – For incompressible flow it becomes $A_1V_1 = A_2V_2$.

Q34. (b) 4 m/s – $V_2 = A_1V_1/A_2 = 0.2 \times 2 / 0.1 = 4$ m/s.

Q35. (c) Streamline – Streamlines show the flow direction at an instant; no flow crosses a streamline.

Q36. (d) Identical – When the flow does not change with time, all three lines coincide.

Q37. (a) Irrotational flow – In irrotational flow the vorticity (curl of velocity) is zero.

Q38. (b) Two-dimensional incompressible flows that satisfy continuity – ψ is defined so that it automatically satisfies 2-D incompressible continuity.

Q39. (c) Irrotational flow – φ exists when the flow is irrotational, because $V = \nabla\varphi$.

Q40. (d) Perpendicular to each other – Together they form a flow net of orthogonal lines.

5. Bernoulli and Momentum Equations

Q41. (a) Euler's equation of motion along a streamline – Integrating Euler's equation along a streamline for steady incompressible flow gives Bernoulli's equation.

Q42. (b) $p/\rho g + V^2/2g + z$ = constant – Pressure head + velocity head + datum head is constant along a streamline (ideal flow).

Q43. (c) Turbulent flow – Bernoulli assumes steady, incompressible, frictionless flow along a streamline.

Q44. (d) $V^2/2g$ – Kinetic energy per unit weight = $V^2/2g$, in metres.

Q45. (a) 9.9 m/s – Torricelli: $V = \sqrt{(2gh)} = \sqrt{(2 \times 9.81 \times 5)} \approx 9.9$ m/s.

Q46. (b) Newton's second law – Net force on a control volume equals the rate of change of momentum.

Q47. (c) 200 N – $F = \rho AV^2 = 1000 \times 0.002 \times 10^2 = 200$ N.

Q48. (d) 2.0 – For the parabolic laminar profile $\alpha = 2$. For turbulent flow it is about 1.03–1.1.

Q49. (a) Velocity head – EGL = HGL + $V^2/2g$.

Q50. (b) Pressure and gravity forces only – Euler's equation neglects viscosity; it balances pressure and gravity forces with inertia.

6. Flow Measurement

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Q51. (c) Discharge through a pipe – It measures flow rate from the pressure drop between the inlet and the throat.

Q52. (d) 0.95–0.99 – Its gradual shape gives small losses, so Cd is close to 1.

Q53. (a) 0.60–0.65 – Sharp contraction and the vena contracta cause larger losses, so Cd is about 0.6.

Q54. (b) Area is minimum and velocity is maximum – Downstream of an orifice the jet contracts to its smallest area, the vena contracta.

Q55. (c) Cd = Cc × Cv – Cd = Cc × Cv (area coefficient × velocity coefficient).

Q56. (d) Velocity at a point – It converts velocity head to pressure head at the stagnation point: V = √(2gh).

Q57. (a) 1.98 m/s – V = √(2gh) = √(2 × 9.81 × 0.2) ≈ 1.98 m/s (Cv taken as 1).

Q58. (b) Variable area – A float rises in a tapered tube until the area around it balances the flow; it is a variable-area meter.

Q59. (c) Open channels – Weirs measure flow over a crest in channels and tanks.

Q60. (d) H^1.5 – Q = (2/3) Cd L √(2g) H^(3/2). For a V-notch, Q varies as H^(5/2).

7. Flow Through Pipes

Q61. (a) 2000 – Re < 2000 laminar, 2000–4000 transition, Re > 4000 turbulent (typical pipe values).

Q62. (b) Inertia force to viscous force – Re = ρVD/μ = inertia force / viscous force.

Q63. (c) $h_f = fLV^2/(2gD)$ – Here f is the Darcy friction factor (f = 4 × Fanning friction factor).

Q64. (d) 64/Re – f = 64/Re. In terms of the Fanning factor this is 16/Re.

Q65. (a) Re and relative roughness – Moody's diagram plots f against Re for different ε/D values.

Q66. (b) $(V_1 - V_2)^2/2g$ – Borda–Carnot result: $h_L = (V_1 - V_2)^2/2g$.

Q67. (c) 0.5 $V^2/2g$ – The entry loss coefficient for a sharp-edged entrance is about 0.5.

Q68. (d) $V^2/2g$ – All the velocity head is lost at the exit, so the coefficient is 1.

Q69. (a) The sum of losses in each pipe – In series, discharge is the same and head losses add up.

Q70. (b) Head loss is the same in each branch – In parallel, each branch has the same head loss and the discharges add up.

8. Laminar Flow and Boundary Layer

Q71. (c) Parabolic – Hagen–Poiseuille flow gives a parabolic profile.

Q72. (d) 2 × average velocity – For a circular pipe u_max = 2 V_avg. Between parallel plates it is 1.5 V_avg.

Q73. (a) Linearly – zero at centre, maximum at wall – τ = (−dp/dx) r/2, so it is zero at the axis and largest at the wall.

Q74. (b) $32\mu VL/D^2$ – $\Delta p = 32\mu V L / D^2$, where V is average velocity.

Q75. (c) Viscous effects are important – Inside the boundary layer velocity rises from zero at the wall to the free-stream value.

Q76. (d) 99% of free-stream – δ is the distance at which u = 0.99 U∞.

Q77. (a) x^0.5 – Blasius: δ = 5x/√Re_x, so δ ∝ x^(1/2). Turbulent layers grow roughly as x^(4/5).

Q78. (b) Adverse pressure gradient is present and wall shear becomes zero – Separation happens under an adverse pressure gradient when (du/dy) at the wall falls to zero.

Q79. (c) 5×10^5 – The critical Reynolds number for a smooth flat plate is about 5×10^5.

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Q80. (d) The wall must be moved to keep the same flow rate in ideal flow – δ* is how far the outer flow is displaced because of the slower fluid in the boundary layer.

9. Dimensional Analysis and Similitude

Q81. (a) n − m – The number of independent dimensionless groups is n − m.

Q82. (b) Inertia force to gravity force – Fr = V/√(gL). It governs open-channel and free-surface flows.

Q83. (c) Flow velocity to speed of sound – Ma = V/c. It is important in compressible flow.

Q84. (d) Surface tension force – We = ρV²L/σ. It matters for droplets, sprays and thin films.

Q85. (a) Pressure force to inertia force – Eu = Δp/(ρV²).

Q86. (b) Froude model law – Wave-making resistance is governed by gravity, so the Froude numbers of model and prototype are matched.

Q87. (c) Reynolds model law – In full pipes viscous forces dominate, so Reynolds numbers are matched.

Q88. (d) Mach model law – Compressibility dominates at high speed, so the Mach number is matched.

Q89. (a) Same ratio of all corresponding lengths – All linear dimensions of the model are scaled by the same factor.

Q90. (b) √L_r – Equal Froude numbers give V_r = √L_r (with the same g).

10. Pumps and Turbines

Q91. (c) Impulse turbine for high head – The Pelton wheel converts all available head into jet velocity before the runner.

Q92. (d) Low head, high discharge – Kaplan is an axial-flow reaction turbine with adjustable blades.

Q93. (a) Mixed-flow reaction turbine – Water enters radially and leaves axially; it suits medium heads.

Q94. (b) Recover kinetic energy and allow the turbine above tailrace level – The diverging draft tube converts exit kinetic energy into pressure and creates suction below the runner.

Q95. (c) N√P / H^(5/4) – For turbines N_s = N√P / H^(5/4). For pumps N_s = N√Q / H^(3/4).

Q96. (d) Filling the suction pipe and casing with liquid before starting – An impeller running in air cannot create enough suction, so the casing is filled first.

Q97. (a) Vapour pressure of the liquid – Vapour bubbles form and collapse, causing noise, vibration and pitting.

Q98. (b) Greater than NPSH required – To avoid cavitation, NPSHa > NPSHr with a safety margin.

Q99. (c) N – Affinity laws: Q ∝ N, H ∝ N², P ∝ N³ (same pump, same diameter).

Q100. (d) Low discharge, high head – Positive-displacement action gives high pressure at small flow rates.

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