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**PRODUCTION AND
INDUSTRIAL ENGINEERING**

Objective Practice Sets

General Engineering : Volume VI

Fluid Mechanics



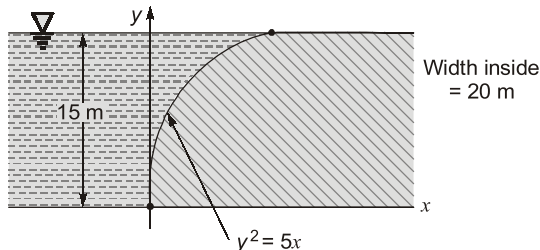
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Fluid Mechanics

- Q.1** If the stream function is given by $\psi = 3xy$, then the velocity at a point (3, 2) will be
 (a) 7.8 m/s (b) 10.11 m/s
 (c) 11.39 m/s (d) 10.816 m/s

- Q.2** A piping system, consists of three pipes arranged in series, the length of the pipes are 1200 m, 1750 m and 600 m and diameters are 750 mm, 680 mm, 850 mm respectively. The equivalent length of pipe of diameter 680 mm is _____m. (Consider same friction factor for all pipes).

- Q.3** A dam is having a curved surface as shown in the figure. The net force acting on the dam is _____ MN. Use $\rho_{\text{water}} = 1000 \text{ kg/m}^3$, $g = 9.81 \text{ m/s}^2$.



- Q.4** The difference in pressure across an air bubble of diameter 0.002 m immersed in water (Surface tension = 0.072 N/m) is
 (a) 72 N/m² (b) 144 N/m²
 (c) 288 N/m² (d) 140 N/m²

- Q.5** For a certain two-dimensional incompressible flow, velocity field is given by $\vec{V} = x\hat{i} - y\hat{j}$, the equation of stream line passing through the point (1, 1) is:
 (a) $xy - 1 = 0$ (b) $\frac{x}{y} - 2 = 0$
 (c) $x - y = 0$ (d) $x(y - 1) = 1$

- Q.6** Consider fully developed flow in a circular pipe with negligible entrance length effects. Assuming the mass flow rate, density and friction factor to

be constant, if the length of the pipe is halved and the diameter is doubled, then ratio of initial to final loss due to friction $\left(\frac{h_{L1}}{h_{L2}}\right)$ is _____.

- Q.7** Oil in a hydraulic cylinder is compressed from an initial volume of 3 m³ to 2.94 m³. If the pressure of oil in the cylinder changes from 120 MPa to 200 MPa during compression, the bulk modulus of elasticity of oil is _____ MPa.

- Q.8** If the velocity distribution over a plate is given by $u = \frac{2}{3}y - y^2$ in which u is the velocity in metre per second at a distance y metre above the plate. Determine the shear stress at $y = 0.15$ m. Take dynamic viscosity of fluid as 8.63 Poise.

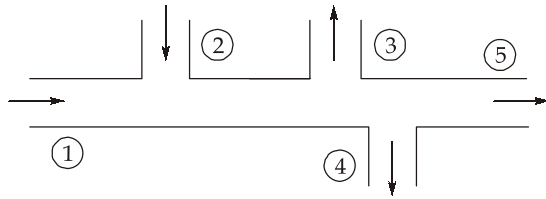
- (a) 0.5756 N/m² (b) 0.3167 N/m²
 (c) 0.2367 N/m² (d) 0.1126 N/m²

- Q.9** A cube of ice floats partly in water and oil. The ratio of the ice immersed in water to that of oil if the density of oil, ice and water are 800 kg/m³, 900 kg/m³ and 1000 kg/m³ respectively, is _____.

- Q.10** The water is flowing through a taper pipe of length 100 m having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 litres/seconds. The pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the higher end is 19.62 N/cm².
 (a) 21.623 N/cm² (b) 22.867 N/cm²
 (c) 24.621 N/cm² (d) 27.128 N/cm²

- Q.11** Two reservoirs are connected by two pipe 1 and 2 of same length and friction factor, in series. If the diameter of pipe 1 is 25% larger than that of pipe 2, the ratio of head loss in pipe 1 to that of pipe 2 is _____.

- Q.12** A pipe flow system with flow direction is shown below

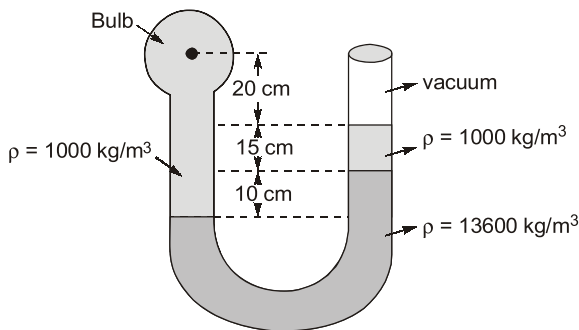


The velocities and corresponding flow across are given in the table below.

Pipe No.	Velocity (cm/s)	Area (cm ²)
1	6	5
2	7	6
3	11	4
4	3	4
5	V_5	4

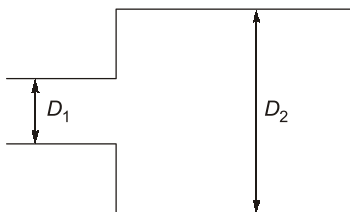
The velocity V_5 (in cm/s) is

- (a) 4 cm/s (b) 6 cm/s
(c) 8 cm/s (d) 2 cm/s
- Q.13** In the figure shown below, the absolute pressure in the bulb is _____ mm Hg.



- Q.14** The fluid is flowing in a duct shaped as shown.

Considering minor losses, the ratio of $\frac{D_2}{D_1}$ for maximum pressure increase across the jump is

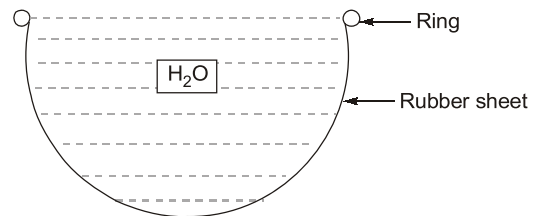


Note: Assume D_1 to be constant.

- (a) 2 (b) 0
(c) $2\sqrt{2}$ (d) $\sqrt{2}$

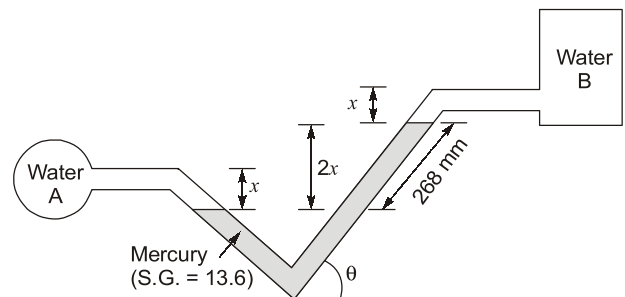
- Q.15** In a top gating system, the diameter of sprue at the top is 20 mm and has a length of 200 mm. If the pouring rate of molten metal is 0.01 m³/min, the area at the bottom of the sprue is
(a) 97.4 mm² (b) 294.18 mm²
(c) 115.4 mm² (d) 81.3 mm²

- Q.16** A sheet of rubber in stretched cut over a ring of radius 0.25 m. After pouring liquid water on it, the rubber forms a half sphere as shown in figure. Neglecting the rubber mass, the surface tension near the ring is equal to



- (a) 153.3 N/m (b) 51.1 N/m
(c) 204.4 N/m (d) 102.2 N/m

- Q.17** Two water tanks are connected to each other through a mercury manometer with inclined tubes, as shown below. The pressure difference between the two tanks is 20 kPa.



The angle 'θ' is equal to _____ degrees.
(Correct to two decimal place)

- Q.18** An air bubble is trapped in a pond at a depth of 0.2 m and has a diameter of 1 cm. The difference between the inside pressures of this air bubble and outside soap bubble of same diameter is (For air water interface, $\sigma = 0.0712$ N/m and for soap bubble air interface, $\sigma = 0.025$ N/m)
(a) 8.48 N/m² (b) 18.48 N/m²
(c) 1.998 kN/m² (d) 1.97 kN/m²

- Q.19** An oil tank contains oil with pressure of air as 80 kPa (abs) as shown in figure. The gate is

Answers Fluid Mechanics

1. (d) 2. (2681.83) 3. (49.3556) 4. (b) 5. (a) 6. (64) 7. (4000) 8. (b)
 9. (1) 10. (b) 11. (0.32768) 12. (a) 13. (77.94) 14. (d) 15. (d) 16. (d)
 17. (34.01) 18. (d) 19. (a) 20. (2) 21. (209.47) 22. (116.37) 23. (b) 24. (b)
 25. (d) 26. (-9) 27. (0) 28. (a) 29. (d) 30. (b) 31. (a) 32. (2)
 33. (c) 34. (a) 35. (a) 36. (1.4) 37. (922.5) 38. (37.5) 39. (785.4) 40. (c)
 41. (183.076) 42. (1.43) 43. (4.45) 44. (1.473) 45. (a) 46. (1.461) 47. (18.0277) 48. (1652)
 49. (b) 50. (c) 51. (b) 52. (b) 53. (b) 54. (c) 55. (a) 56. (b)
 57. (173.596) 58. (c) 59. (a) 60. (6.96) 61. (35.40) 62. (a) 63. (c) 64. (c)
 65. (b) 66. (d) 67. (a) 68. (a) 69. (Sol.) 70. (b) 71. (c) 72. (d)
 73. (a) 74. (b) 75. (a) 76. (c) 77. (b) 78. (d) 79. (d) 80. (b)
 81. (c) 82. (c) 83. (c) 84. (a) 85. (c) 86. (d) 87. (d) 88. (a)
 89. (c) 90. (c) 91. (c) 92. (d) 93. (b) 94. (b)

Explanations Fluid Mechanics**1. (d)**

$$u = -\frac{\partial \psi}{\partial y} = -\frac{\partial}{\partial y}(3xy) = -3x$$

$$v = \frac{\partial \psi}{\partial x} = \frac{\partial}{\partial x}(3xy) = 3y$$

$$\begin{aligned} V &= \sqrt{u^2 + v^2} \\ &= \sqrt{(-3x)^2 + (3y)^2} \\ &= \sqrt{9x^2 + 9y^2} \\ &= 3 \times \sqrt{x^2 + y^2} = 3 \times \sqrt{9 + 4} \\ &= 10.816 \text{ m/s} \end{aligned}$$

2. (2681.83)

$$h_L = \frac{f l Q^2}{12.1 D^5}$$

For pipe in series,

$$\begin{aligned} \frac{f l_{eq} Q^2}{12.1 D_{eq}^5} &= \frac{f l_1 Q^2}{12.1 D_1^5} + \frac{f l_2 Q^2}{12.1 D_2^5} + \frac{f l_3 Q^2}{12.1 D_3^5} \\ \frac{l_{eq}}{(680)^5} &= \frac{1200}{(750)^5} + \frac{1750}{(680)^5} + \frac{600}{(850)^5} \\ l_{eq} &= 2681.83 \text{ m} \end{aligned}$$

3. (49.3556)

Horizontal force,

$$\begin{aligned} F_H &= \rho g \times \frac{H}{2} \times H \times W \\ &= 1000 \times 9.81 \times \frac{15^2}{2} \times 20 \text{ N} \\ &= 22.0725 \text{ MN} \end{aligned}$$

Vertical force,

$$\begin{aligned} F_r &= \text{Weight of water retained upto the free surface} \\ &= \rho g W \int dA = \rho g W \int \frac{y^2}{5} dy \\ &= \frac{1000 \times 9.81 \times 20}{5} \times \left(\frac{15^3}{3} \right) \text{ N} \\ &= 44.145 \text{ MN} \\ F_{\text{net}} &= \sqrt{F_H^2 + F_r^2} = 49.3556 \text{ MN} \end{aligned}$$

4. (b)

$$\begin{aligned} \Delta P &= \frac{4\sigma}{d} \\ &= \frac{4 \times 0.072}{0.002} \\ \Delta P &= 144 \text{ N/m}^2 \end{aligned}$$