1	D	2	B	3	C	4	B	5	0.02	6	B	7	B	8	D	9	A
10	0.5	11	D	12	C	13	A	14	A	15	C	16	A	17	1.5	18	C
19	A	20	B	21	B	22	C	23	A	24	A	25	B	26	A	27	A
28	D	29	60	30	A	31	A	32	307.5	33	B	34	D	35	10165	36	B
37	38.77	38	C	39	D	40	A	41	A	42	B	43	C	44	B	45	A
46	B	47	A	48	C	49	C	50	C	51	A	52	354	53	D	54	D
55	B	56	A	57	D	58	B	59	D	60	D	61	C	62	B	63	C
64	D	65	D														

3. Given data, For water droplet.

D = 0.05cm.

p = 0.5KPa.

$$\Delta P = \frac{46}{D} \Rightarrow 6 = \frac{\Delta PD}{4}$$

$$\therefore \quad \sigma = \frac{0.5\times1000\times0.05}{4} = 0.0625 N/m$$

4. $k = 3.2GPa$

$$\therefore \quad k = \frac{P}{\frac{\Delta V}{V}} \Rightarrow 3.2 \Rightarrow P = 2.56GPa$$

5. Weight of water displaced = Weight in air – Weight in water

$$= 392.4 - 196.2 = 196.2\text{N}$$

Volume of water displaced = $\frac{196.2}{10^3\times9.81} = .02\text{m}^3$

16.

$$\delta = \int_0^\delta \left(1-\frac{u}{U}\right)dy = \frac{\delta}{2}$$

18. laminar flow

$$\frac{dp}{dx} = \frac{8\mu Q}{\pi R^4}$$

$$\left(\frac{dp}{dx}\right)_2 = \left(\frac{8\mu Q}{\pi(2R)^4}\right)$$

$$\left(\frac{dp}{dx}\right)_2 = 16\left(\frac{8\mu Q}{\pi R^4}\right)$$

$$\left(\frac{dp}{dx}\right)_2 = 16\left(\frac{dp}{dx}\right)$$

22. $P_1 = 13.7\times10^4 \text{N/m}^2$

$P_2 = -37$cm of Hg = -5.03m of water

differential head = $\frac{P_1}{\rho g} - \frac{P_2}{\rho g}$

$$= \frac{13.7\times10^4}{10^3\times9.81} - (-5.03)$$

$= 19.03$ m of water

26. (A)

In a sudden expansion, the loss of head

$$h_L = \frac{(V_1-V_2)^2}{2g}$$

For an expansion in a horizontal pipe

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + \frac{(V_1-V_2)^2}{2g}$$

$$\left(\frac{p_2}{\gamma} - \frac{p_1}{\gamma}\right) = \frac{\Delta p}{\gamma}$$

$$= \frac{V_1^2}{2g} - \frac{V_2^2}{2g} - \frac{(V_1-V_2)^2}{2g}$$

By continuity

$$V_1D_1^2 = V_2D_2^2$$

$$V_2 = V_1\left(\frac{D_1}{D_2}\right)^2 = V_1x^2$$

Where, $x = \left(\frac{D_1}{D_2}\right)$

$$\therefore \frac{\Delta p}{\gamma} = \frac{V_1^2}{2g}(1-x^4) - \frac{V_1^2}{2g}(1-x^2)^2$$

$$= \frac{V_1^2}{2g}\left[1-x^4-(1-x^2)^2\right]$$

For maximum pressure differential

$$\frac{d(\Delta p/\gamma)}{dx} = 0$$

$$\therefore -4x^3 - 2(1-x^2)(-2x) = 0$$

$$-2x^3 + 2x - 2x^3 = 0$$

or $(2x^2-1) = 0$ or $x = \frac{1}{\sqrt{2}}$

i.e. $D_2 = \sqrt{2}D_1$

27. **(A)**

$\because$ In parallel combination.

$$h_{f_1} = h_{g_2}$$

$$\frac{flV_1^2}{D_1 2g} = \frac{flV_2^2}{D_2 2g}$$

$$\frac{V_1^2}{D_1}=\frac{V_2^2}{D_2}\Rightarrow\frac{Q_1^2}{Q_2^2}=\left(\frac{D_1^5}{D_2^5}\right)^{\frac{1}{2}}$$

$$=\left(\frac{0.2}{0.3}\right)^{\frac{5}{2}}=0.363$$

29.

$$\because h_f=\frac{H}{3}$$

$$\Rightarrow H=3h_f=3\times 20=60\text{ m}$$

30. D = 4 mm = 0.004m

No. of droplet = 1000

σ = 0.07 N/m

Volume of Big drop = 1000 $\times$ Volume of small drop

$$\Rightarrow \quad \frac{4}{3}\pi R^3=1000\times\frac{4}{3}\pi r^3$$

$$\Rightarrow \quad 0.002^3=1000r^3$$

$$\Rightarrow \quad r=2\times10^{-4}m$$

Original surface area $=4\pi R^2$

$$=5.026\times10^{-5}m^2$$

Total surface area of 1000 droplets

$$=1000\times4\pi R^2$$

$$=5.026\times10^{-4}m^2$$

Increase in surface are

$$=4.5234\times10^{-4}m^2$$

Work done $=\sigma\times$ Increase in surface area

$$W=3.166\times10^{-5}J.$$

31. $F=\rho QV=\rho AV^2$

At Section (1) –

$$V_1=\sqrt{2gH_1}$$

$$F_1=\rho\left(\frac{\pi}{4}D_1^2\right)(2gH_1)$$

At Section (2) –

$$V_2=\sqrt{2g\frac{H_1}{2}}$$

$$F_2=\rho\left(\frac{\pi}{4}D_2^2\right)\left(2g\frac{H_1}{2}\right)$$

Net horizontal force = 0

$(F_1=F_2)$

$$D_1^2\times2H_1=D_2^2H_1$$

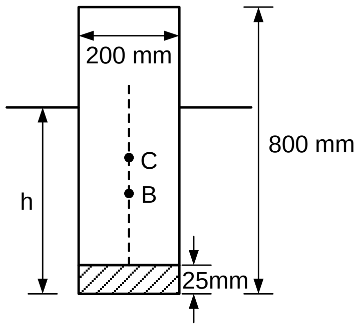
$$D_2=\sqrt{2}D_1$$

32. The volume by the entire cylinder is

$$V=\frac{\pi}{4}\times0.2^2\times0.8$$

$$=0.0314\times0.8$$

$$=0.025m^3$$



Weight of the cylinder –

$$W=0.0314\times(0.8-0.025)\times600g$$

$$+0.0314\times0.025\times6000g$$

$$=143.2+46.2$$

$$=189.4N$$

Since cylinder is floating,

F_B = W

$$\because h\times0.0314\times1000\times9.81=189.4$$

$$h=0.615m$$

Distance of center of buoyancy from free surface = $\frac{h}{2}$ = 0.3075m = 307.5mm

33

$$(z_1-z_2)-\frac{v_2}{2g}=hf$$

$$h_f=\frac{32\mu VL}{\rho gD^2}$$

$$\frac{32\mu V_2L}{\rho gD_2}=1.5-\frac{V_2^2}{2g}$$

$$\frac{32\times15\times v_2\times0.70}{920\times9.81\times0.022}=\frac{1.5-V_2^2}{2\times9.81}$$

$$V_2=1.5m/s^2$$

$$Q=AV$$

$$=\frac{\pi}{4}\times0.02^2\times1.49$$

$$Q=4.681\times10^{-4}m^3/s$$

34. Velocity of water in hose

$$=\frac{Q}{A}$$

$$= \frac{0.001 \times 4}{\pi (0.05)^2}$$

$$= 0.509\, m/s$$

Applying birnouli at point 1.2

$$\frac{P}{\rho g} + h = 15 + \frac{u^2}{2g} + 0.055$$

$$\frac{P}{\rho g} = 15 + \frac{(.509)^2}{2 \times 9.81} + 0.055$$

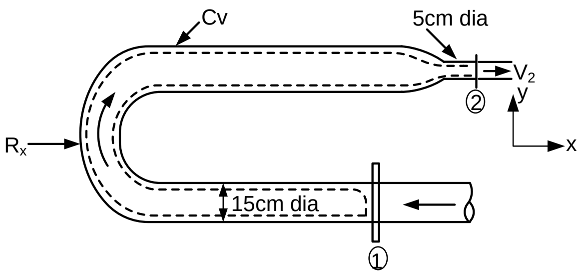
$$= 15.068\, m \text{ of water}$$

$$P = 15.068 \times 9810$$

$$P = 14781.9\, KN/m^2$$

$$\boxed{P = 147.819\, kPa}$$

35. $Q = \frac{\pi}{4}(D_2)^2 V_2 = 0.06\, m^3/s$



$$V_2 = \frac{0.06}{\frac{\pi}{4} \times (0.05)^2} = 30.56\, m/s$$

$$V_1 = V_2 \left(\frac{D_2}{D_1}\right)^2$$

$$= 30.56 \times \left(\frac{0.05}{0.15}\right)^2$$

$$= 3.395\, m/s$$

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

$$\left(\because P_2 = Atmospheric \therefore \frac{P_2}{\rho_g} = 0 \right)$$

$$\frac{P_1}{\rho g} + \frac{3.395^2}{2 \times 9.81} = \frac{(30.56)^2}{2 \times 9.81}$$

$$P_1 = 460.2\, KPa$$

Applying moment equation

$$\Rightarrow -P_1 A_1 + R_x - 0 = \rho Q (V_2(-V_1))$$

$$\Rightarrow (460.2 \times 10^3) \times \frac{\pi}{4} \times (.15)^2 + R_x$$

$$= 998 \times 0.06 \times (30.56 + 3.39)$$

$\Rightarrow R_x = 10165 N$ and acts to the left as a pull on the joint

Sol.36. Pressure Head at A, g = 10 m/s^2

Press head $= \frac{10}{10} + 0.85 \times 4 + 0.5$

$= 1.84$ m of water

Balancing Energy at nozzle exit & point A

$$\frac{P_N}{\rho g} + \frac{U_N^2}{2g} = \frac{P_A}{\rho g} + 0.5 \,(P_N = 0)$$

$$U_N = 6.78\, m/s$$

$$Q = U_P A_P = U_N A_N = 53.24\, L/S$$

$$U_P = 6.78 \times \left(\frac{10}{20}\right)^2 = 1.695\, m/s$$

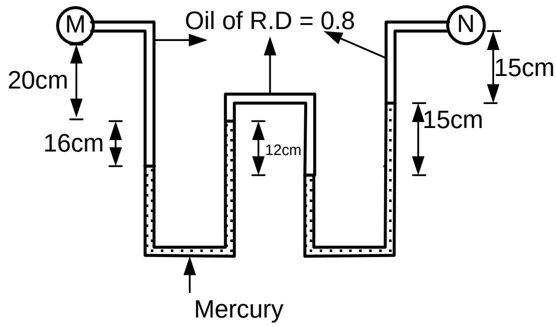
$$U_P = 1.695\, m/s$$

Energy Balance for height

$$h = \frac{UN^2}{2g}$$

$$\boxed{h = 2.34\, m}$$

Sol.37. Let us equate pressure across X – X.



$$P_M + 0.2 Y_O + 0.16 Y_O$$

$$= P_N + 0.15 Y_O + 0.15 Y_M - 0.12 Y_O$$

$$+ 0.12 Y_M + 0.04 Y_M$$

$Y_O = Sp.wt.$ of oil = 0.8 × 9810

$$= 7848\, N/m^3$$

Y_M = Sp.wt of mercury = 13.6×9810=133416 N/m^3

$$P_M - P_N = -0.36 \times 7848 + 0.15 \times 7848 - 0.12 \times 7848$$

$$= 38769.12\, Pa.$$

$$\boxed{P_M - P_N = 38.77\, KPa}$$

Sol.38. For the given semicircular lamina :

$r = 1.0m$

$h = 4.0$

Area (A) $= \frac{\pi r^2}{2} = \frac{\pi}{2} = 1.57 / m^2$

& $\bar{h} = h\left(\frac{4r}{3\pi}\right) = 4.0 - \left(\frac{4}{3\pi}\right) == 3.576m$

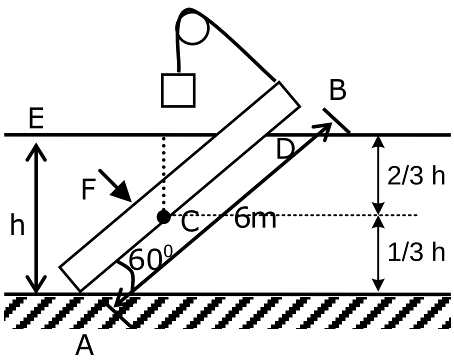
Hence force on one side of the plate $= \rho g A\bar{h}$

$= 9.79 \times 1.571 \times 3.576 = 55KN$

39 D

$$h = \frac{4\sigma\cos\theta}{\rho g d} = \frac{4 \times 0.075 \times \cos 30^0}{10^4 \times 0.005} = 5.19mm$$

40 and 41



Let h be the height of water over the gate.

AE = h

AD = $\frac{AE}{\sin 60^0} = \frac{2h}{\sqrt{3}}$

Area of gate immersed in water $= \frac{2h}{\sqrt{3}} \times 3 = 2\sqrt{3}hm^2$

Depth of C.G. of the immersed area = $\bar{h} = \frac{h}{0.2} = 0.5h$

Total force F = $= \rho g 2\sqrt{3}h \times \frac{h}{2} = \sqrt{3}\rho g h^2 N$

Centre of force will be from A $= \frac{h}{3 \times \sin 60} = \frac{2h}{3\sqrt{3}}$

taking moments about A

$$W \times 6 = F \times \frac{2h}{3\sqrt{3}}$$

$$60 \times 10^3 \times 6 = \rho g\sqrt{3} \times h^2 \times \frac{2h}{3\sqrt{3}}$$

$$h = 3.8m$$

Total force, $F = \sqrt{3}\rho g h^2 = 245.35kN$

42 $u = 3xy^2,\ v = 2xy,\ w = (2zy + 3t)$

At point (1,2,1) and t = 3,

$u = 12,\ v = 4,\ \ w = 13$

In vector form $\Rightarrow 12\hat{i} + 4\hat{j} + 13\hat{k}$

43. (C)

Given: $\vec{V} = ax\hat{i} + ay\hat{j}$

i.e. $u = ax$ and $v = ay$

Equation of steam line is given by

$\frac{dx}{u} = \frac{dy}{v}$

$\Rightarrow \frac{dx}{ax} = \frac{dy}{ay}$

$\Rightarrow \frac{dx}{x} = \frac{dy}{y}$

Integrating both sides, we get

Inx = Iny + Inc

(where c is constant of integration)

$\therefore \quad x = cy$

Since the stream line passed through point (1,2) therefore

$1 = 2c$

$c = 1/2$

Hence equation of stream line is

$x = \frac{1}{2}y$

$\Rightarrow 2x - y = 0$

44. (B)

$C_{v1} = \sqrt{\frac{x^2}{4HY}}$

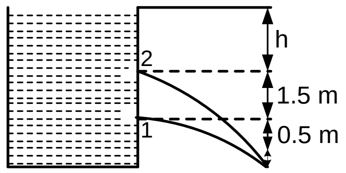


Figure 4.52

$\therefore \frac{x^2}{4 \times 0.5 \times (h + 1.5)} = \frac{x^2}{4 \times 2 \times h}$

$\therefore h = 0.5m$

total height – 0.5 + 1.5 + 0.5 = 2.5m

45

$$h_f = \left(\frac{1}{C_c} - 1\right)^2 \frac{u_2^2}{2g}$$

$$h_f = \left(\frac{1}{0.66} - 1\right)^2 \times 1.25$$

46

Boundary Layer thickness $\propto \sqrt{\text{distance from leading edge}}$

$$\frac{\delta_1}{\delta_2} = \sqrt{\frac{y_1}{y_2}},\ \frac{5}{\delta_2} = \sqrt{\frac{1}{2}} \Rightarrow \delta_2 = 5\sqrt{2}\text{mm}$$

47 A

$$Q = 3.5\ lit/\sec = \frac{3.5}{1000} = 0.0035\ m^3/\sec.$$

$$u = \frac{Q}{\frac{\pi}{4}D^2} = \frac{0.0035}{\frac{\pi}{4}(0.050)^2} = 1.782\ m/\sec$$

Pressure drop, $\Delta P = \dfrac{32\mu uL}{D^2} = 684.288\ \text{KN/m}^2$.

48 Velocity ratio of prototype & model is

$$\frac{V_P}{V_m} = \frac{L_P}{L_m} = 5,$$

$$\frac{A_P}{A_m} = \left(\frac{L_P}{L_m}\right)^2 = 25$$

discharge ratio $= \dfrac{Q_P}{Q_m} = \dfrac{A_P V_P}{A_m V_m} = 25 \times 5 = 125$

$, \Rightarrow Q_P = Q_m \times 125 = 25 m^3/s$

49 For maximum efficiency, $u = \dfrac{V_1}{2}$

$V_1 = \sqrt{2gH}$ — V_1 = velocity of jet, H = head availbale

$\Rightarrow$ $H = 20.38$m

50. (C)

$$\phi = 180^0 - 120^0 = 60^0$$

Power developed by pelton wheel

$$= \rho Q(v-u)(1+\cos\phi)u$$

$$= 1000 \times 0.1(25-10)(1+\cos 60^0) \times 10$$

$$= 22500W = 22.5kW$$

51. (A)

For similar turbines specific power will be same.

$$\frac{P_1}{d_1^2 H_1^{3/2}} = \frac{P_2}{d_2^2 H_2^{3/2}}$$

$$\therefore P_2 = P_1 \times \left(\frac{d_2}{d_1}\right)^2 \times \left(\frac{H_2}{H_1}\right)^{3/2}$$

$$= 300 \times \left(\frac{1}{4}\right)^2 \times \left(\frac{10}{40}\right)^{3/2}$$

$$p_2 = 2.34kW$$

52.

For unit quantities

$$\frac{P_1}{H_1^{3/2}} = \frac{P_2}{H_2^{3/2}}$$

$$P_2 = P_1 \left(\frac{H_2}{H_1}\right)^{3/2}$$

$$= 1000 \times \left(\frac{20}{40}\right)^{3/2} = 353.6 = 354kW$$

53

$$\phi = x(2y-1)$$

$$u = \frac{\partial\phi}{\partial x} = (2y-1)$$

$$v = \frac{\partial\phi}{\partial y} = 2x$$

Also, $u = \dfrac{\partial\psi}{\partial y} = 2y - 1$

$$\psi = y^2 - y + c \Rightarrow \frac{\partial\psi}{\partial x} = \frac{\partial c}{\partial x}$$

$$v = \frac{-\partial\psi}{\partial x} = -2x \Rightarrow \frac{\partial c}{\partial x} = -2x$$

Or, $c = -x^2$

So, $\psi = y^2 - y - x^2$

54 $u = \dfrac{\partial\psi}{\partial y} = 2y = 4,\ v = \dfrac{-\partial\psi}{\partial x} = -2x = -2$

55

$$P_{abs} = P_{gauge} + P_{atm} = \rho_l g h_l + \rho_{hg} g h_{hg}$$

$$= 0.8 \times 10^3 \times 9.81 \times 2 + .760 \times 13.6 \times 10^3 \times 9.81 = 117$$

Sol.56. (A)

Sol.57. (D)

Intensity increases from A Chill is intense cold just as tepid is moderate and hot is high intensity ,

Sol.58. (B)

Sol.59. (D)

The three words – Portico and Reception refer to the entrance part of a building or a hotel while corridor is in an interior part of a building

Sol.60. (D)

The author of the passage tries to state that philosophy is a way of liging and therefore it should be taught to students as early as possible. Hence the right answer is option D.

Sol.61. (C)

Let the total marks be x. If we add 45 marks to X, then he will pass

$\therefore$ Pass mark of X = 30 % of x + 45

If we subtract 115 marks to Y, then will obtain pass mark

I.e. pass mark of Y = 50% of x + 115

Pass mark in both the cases must be always equal

$\therefore$ 50% of x – 115 = 30% of x + 45

$\Rightarrow$ 20% of x = 160 $\Rightarrow$ 100% of x = 800 $\therefore$ The total marks is 800

Sol.62. (B)

Given that certain amount becomes five times after 3 years under compound interest, So after next 3 years it will be 5 times of the previous amount and so on.

End of year	No of times
3	5
6	5(5) = 25
9	5(25) = 125
12	5(125) = 625

$\therefore$ After 12 years the amount will be 625 times.

Sol.63. (C)

we know time of departure of trans P and q, In order to answer r the question we require speeds of trains. (OR) speed of train Q and distance traveled by train P in $1^{1/2}$ hrs i.e. the distance between two trains at 11:30a.m

Statement I alone is not sufficient to answer as the speed of train P is not known,

Statement Ii alone is not sufficient to answer as the speed of train q is not known.

Combining statement I and II we can answer the question.

Sol.64. (D)

Year	P	Q	R	S
2007	10,000	20,000	30,000	15,0000
2008	40,000	20,000	50,000	10,000
2009	20,000	70,000	10,000	5,000
Average sales of least and highest	25,000	45,000	30,000	10,000

The required ratio is 25,000 : 45,000: 30,000: 10,000=5: 9: 6: 2

Sol.65. (D)