ACE Engineering Academy
Head Office : Sree Sindhi Guru Sangat Sabha Association, # 4-1-1236/1/A, King Koti, Abids, Hyderabad - 500001.
Ph: 040-23234418, 040-2324419, 040-2324420, 040-24750437
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ESE- 2020 (Prelims) - Offline Test Series Test- 9

CIVIL ENGINEERING

SUBJECT: FLUID MECHANICS & OPEN CHANNEL FLOW, HYDRAULIC MACHINES AND HYDRO POWER + SURVEYING AND GEOLOGY

01. Ans: (c)

Sol: By trapezoidal formula

Volume of water

$$=\frac{L}{2}\left(A_1+A_5+2\left(A_2+A_3+A_4\right)\right)$$

$$=\frac{5}{2}\left(150+850+2\left(300+500+700\right)\right)$$

$= 10,000\ m^3$

02. Ans: (b)

Sol: Distance between A & B is 10 m

Contour interval = 0.25 m

Number of contour lines $=\frac{10}{0.25}=40$

RL change from A B = 98.75 – 96.75 = 2 m

RL change for 97.5 m contour from A

= 97.5 – 96.75

= 0.75 m

For 2 m RL change 10 m distance was covered

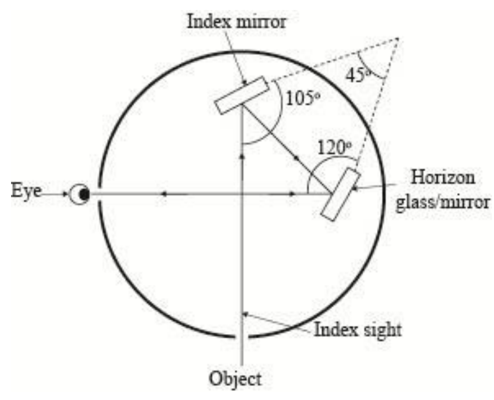
To 0.75 m RL change (By Unitary method)

2 m RL change = 10 m

0.25 m RL change $=\frac{10}{2}\times 0.75=3.75\,m$

03. Ans: (d)

Sol:



04. Ans: (b)

Sol: Representative fraction (RF)

$$=\sqrt{\frac{\text{Area on map}}{\text{Area on ground}}}$$

Area on ground = 3.2 hectare

$= 3.2\times 10000\ m^2$

$= 32000\ m^2$

$$RF=\sqrt{\frac{5\times 10^{-4}}{32000}}=\frac{1}{8000}$$

05. Ans: (a)

Sol: True difference in elevation between A & B

$$H = \frac{(2.1-2.6)+(0.65-1.15)}{2} = -0.5 \text{ m}$$

RL of A = 101.500 mm

RL of B = RL of A – (– H)

= 101.5 + 0.5 = 102 m

06. Ans: (c)

Sol: Combined correction = $0.0673D^2$, D in km

$= 0.0673 \times 4^2$

= 1.076 m

07. Ans: (a)

Sol: Original scale 1 cm = 20m i.e. $\frac{1}{2000}$

Actual length = 15cm

Incorrect length L^1 = 14.5cm

shrinkage factor = $\frac{14.5}{15}$

Corrected scale = Original scale ×S.F

$$= \frac{1}{2000} \times \frac{14.5}{15}$$

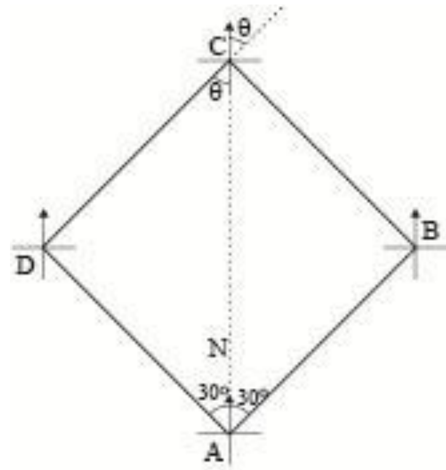
$$= \frac{1}{2068.96}$$

i.e. 1 cm = 2068.96 cm

= 20.69 m

08. Ans: (c)

Sol:



Since ABCD is a regular parallelogram;

Bearing of line AB = $30^0 = \theta$

∴ Bearing of line CD = 180 + 30 = 210^0

09. Ans: (c)

Sol: Three point problem can be solved using

(a) Lehmann's method (or) trail and error method.

(b) Graphical method like Bessel's solution

(c) Mechanical method (using tracing sheet/cloth)

(d) Analytical method.

(e) Geometrical construction method.

In two point problem a subsidiary/ auxiliary station is chosen in the first step.

Hence 2, 3 are correct.

10. Ans: (c)

Sol: Height of light house = 196m

Distance between ship and light house, so that top of light house is just visible from ship is ('h' is in m)

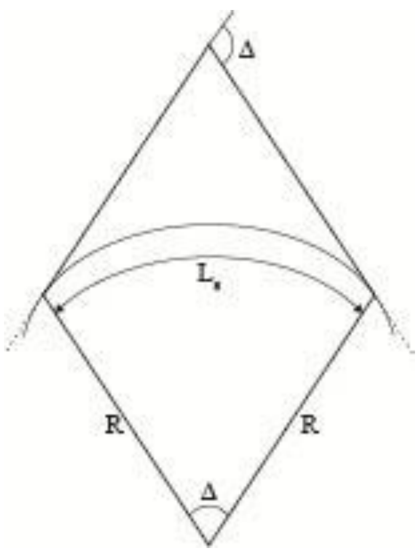
$$d = \sqrt{\frac{h}{0.06735}}\,km$$

$$= 3.85\sqrt{h}\ km$$

$$= 3.85\sqrt{196} = 53.9\,km \simeq 54\ km$$

11. Ans: (b)

Sol:



Given $\Delta = 8^0$

Length of transition curve

$= 2L_s$

$= 2 \times (R\ \Delta)$

$$= 2 \times \left(500 \times 8 \times \frac{\pi}{180}\right)$$

$= 139.62\ m \simeq 140\ m$

12. Ans: (d)

Sol: Shift of the curve

L_s = Length of transition curve

R = Radius of circular curve

$$= \frac{120^2}{24 \times 300} = 2\ m$$

13. Ans: (d)

Sol: Standard meridian = 82°30'

Longitude of a place = 90°E

Corresponding time = 8hr 30m

Difference in meridian = 90° - 82 30'

= 7° 30'

For 360° = 24 hrs

$$\text{For } 7°30' = \frac{7°30'}{360°} \times 24$$

= 0.5 hrs = 30 min

$$\begin{pmatrix}\text{Local mean}\\ \text{time}\end{pmatrix} = \begin{pmatrix}\text{standard}\\ \text{time}\end{pmatrix} \pm \begin{pmatrix}\text{difference}\\ \text{of longitude}\end{pmatrix}$$

(+) when the place is to east of standard meridian

(-) when the place is to west of standard meridian

∴ LMT = 8hr 30 m + 30 mn

= 9hr. 00 min

14. Ans: (a)

Sol: $d = \frac{rh}{H}$

$= \frac{6.35 \times 50}{1250} = 0.254 \text{ cm}$

15. Ans: (b)

Sol:

$X_a = \frac{B}{P} x_a$

$= \frac{425 \times 61.42}{11.62} = 2246.42 \text{ m}$

$Y_a = \frac{B}{P} \times y_a = \frac{425 \times 48.30}{11.62} = 1766.56 \text{ m}$

16. Ans: (d)

Sol: True bearing of sun at noon is= 180°

Magnetic declination = T.B – M.B

$= 180^o - 186^o30$

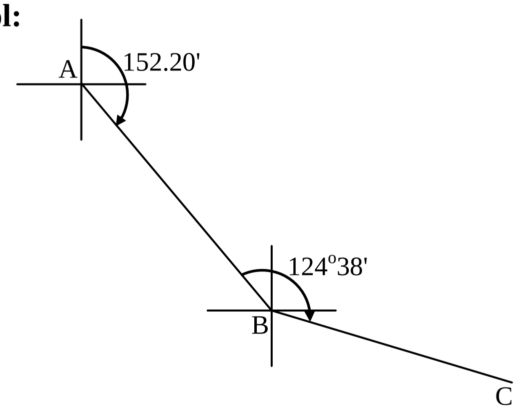
$= -6^o30'$

Negative sign indicates declination towards westward

i.e. Declination = $6^o30'$ W

17. Ans: (c)

Sol:



Bearing of BC = $124^o38' - (360^o - \text{BB of A})$

$= 96^o58'0''$

18. Ans: (d)

19. Ans: (c)

Sol: $l \cos\theta = 13 \text{ m} \rightarrow (2)$

$l \sin\theta = 17 \text{ m} \rightarrow (1)$

$(l\cos\theta)^2 + (l\sin\theta)^2 = l^2$

$\therefore l = 21.4 \text{ m}$

20. Ans: (d)

Sol: Arithmetic check:

ΣB.S – ΣF.S = 2.194 – 0.408 = 1786

$RL_{last} - RL_{1st}$ = 809.652 – 807.854 = 1.798

Actual difference between RL.s = 1.798

Difference by levelling is = 1.786

Correction is +ve and error is negative

Error = 1.786 – 1.798 = – 0.012 m

21. Ans: (b)

Sol:

Station	**Chainage**	**Staff Reading (m)**			**H.I**	**RL**	**Remarks**
		BS	**IS**	**FS**			
A	30	0.585					
B	30		0.936				
C	30		1.953				
D	30		2.846				
E	30		3.644				
F	30	0.962		3.938			CP
G	30		1.035				
H	30		1.689				
I	30		2.534				
J	30	0.962		3.844			CP
K	30		1.579				
L	30			3.016			

22. Ans: (c)

Sol: Permanent adjustments of theodolite are:

i. Axis of plate level is perpendicular to vertical axis
ii. Horizontal axis is perpendicular to vertical axis
iii. Line of collimation is at right angles to horizontal axis.
iv. Axis of altitude level is parallel to line of collimation when horizontal and vertical circle in that case must read zero.

23. Ans: (b)

Sol: The scale adopted for topographical maps is

1cm = 0.25 km to 2.5 km

i. e. 1 : 25000 to 1 : 2,50,000

Hence the smallest scale is 1 : 2, 50, 000

Note:

Scale for geographical maps is 1cm

= 5 km to150 km

i.e. 1:5,00,000 to1: 150,00,000

Scale for cadastral maps is 1cm

= 10m to 50m i.e., 1 : 1000 to 1 : 5000

Scale for building site is 1cm

= 10 m i.e.,1 : 1000

Scale for forest map is 1cm

= 250 m i.e. 1: 25000

Note: Location maps have largest scale. Hence appropriate option is 1cm = 5m to 25m.

Geographical maps have smallest scale and are followed by topographical maps.

Hence scale of geographical maps is

1cm = 160 km and of topographical maps is

1 cm = 2.5 km

24. Ans: (d)

Sol: Weathering is defined as, a natural process of in-situ mechanical disintegration and or chemical decomposition of the rocks of the crust of the Earth by certain physical and chemical agencies of the atmosphere. It is a very slow process.

25. Ans: (b)

Sol: The basic definition of structural geology is “the branch of geology which deals with the morphology, classification, mechanism and causes of development of these rock structures”. Hence the answer Structural Geology.

26. Ans: (b)

Sol: Austrian mineralogist F.Mohs proposed a relative, broadly quantitative "scale of hardness" of minerals assigning values between 1 and 10.

27. Ans: (c)

Sol: Cleavage is defined as the tendency of a crystallized mineral to break along certain directions yielding more or less smooth, Plane surfaces. In other words, cleavage are the planes easiest fractures, and are essentially indicative of directions of least cohesion.

28. Ans: (d)

Sol: Among granite and sandstone exposed to atmosphere simultaneously in the same or adjoining areas having hot and humid climate, the sandstone will resist weathering to a great extent because they are made up mainly of quartz (SiO_2) which is highly weathering resistant mineral.

29. Ans: (a)

Sol: Igneous rocks are formed from cooling and crystallization of hot molten material called magma/lava depending on the place of occurrence. The magma gets intruded or injected into the pre-existing rocks of any type-called the host rocks and takes variously shaped forms on cooling. These forms are commonly termed as Intrusion.

30. Ans: (b)

Sol: Because of a very slow rate of cooling at the depths, the rocks resulting from magma are coarse grained. These rocks get exposed on the resulting from magma are coarse grained. These rocks get exposed on the surface of the earth as a consequence of erosion of the overlying strata.

31. Ans: (d)

Sol: Anticlines are said to convex upwards and not downwards. Synclines are convex downwards.

32. Ans: (b)

Sol: The frictional loss depends on loss in kinetic energy with respect to bucket. It is given by

$$h_{fb} = \frac{V_{r1}^2 - V_{r2}^2}{2g} = \frac{V_{r1}^2 - (kV_{r1})^2}{2g}$$

$$= \frac{V_{r1}^2(1-k^2)}{2g}$$

$$= \frac{(V-u)^2}{2g}(1-k^2)$$

$$= \frac{(90-40)^2}{2\times 9.81}\times(1-0.95^2) = 12.4 \text{ m}$$

33. Ans: (d)

Sol: The number of buckets on wheel (z) is given as:

$$Z = 0.5\left(\frac{D}{d}\right)+15 \rightarrow \text{Taygun's formula}$$

$$= 0.5\times\frac{2.4}{0.12}+15 = 25$$

34. Ans: (d)

Sol: The minimum permissible NPSH is given by:

NPSHR = $\sigma_c H_m = 0.1\times 30 = 3$ m

$\therefore H_a - H_{s,\,max} - H_v - h_{fs} = 3$m

i.e., $10.3 - H_{s,\,max} - 0.3 - 0.5 = 3$

$\Rightarrow H_{s,\,max} = 6.5$ m

35. Ans: (b)

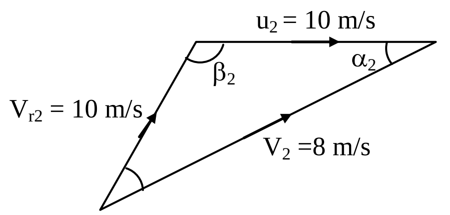
Sol: The shaft power (S.P) required to drive the pump is given by,

$$S.P = \frac{\rho g Q H}{\eta_0} = \frac{800\times 9.81\times 0.025\times 12}{0.75}$$

$$= 3.14 \text{ kW}$$

36. Ans: (a)

Sol:



As 18 m/s is vector sum of other two vectors, it must be absolute velocity.

As $\beta_2 > 90^\circ$ (or $V_{w2} > u_2$),

it is forward vane impeller

From the velocity triangle,

$$\cos\beta_2 = \frac{V_{r2}^2 + u_2^2 - V_2^2}{2\times V_{r2}u_2}$$

$$= \frac{10^2+10^2-18^2}{2\times 10\times 10} = -0.62$$

$$\Rightarrow \beta_2 = \cos^{-1}(-0.62) = 128^\circ$$

Note: As angle β_2 is obtuse as per diagram the options (b) and (d) can be directly eliminated.

37. Ans: (c)

Sol: $Q \propto D^2\sqrt{H} \propto D^2(ND) \quad \{\because ND \propto \sqrt{H}\}$

$\propto D^3N$

$P \propto D^2H^{3/2} \propto D^2(ND)^3 \quad \{\because ND \propto \sqrt{H}\}$

$\propto D^5N^3$

38. Ans: (b)

Sol: When the tube is accelerated by acceleration a in right direction, pressure increases from C to D and increases in pressure is ρ a h_{CD}

$\therefore\ P_D = P_C + \rho a h_{CD} = P_{atm} + \rho a h_{CD} \rightarrow (1)$

But $P_D = P_B + \rho g h_{BD} = P_{atm} + \rho g h_{BD} \rightarrow (2)$

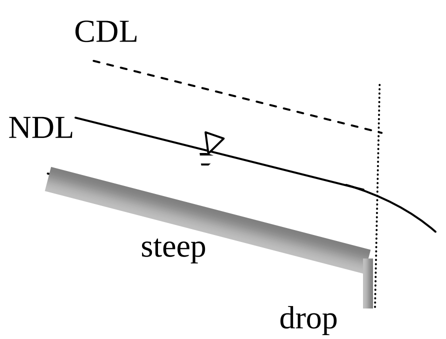
$\therefore$ From (1) and (2)

$P_{atm} + \rho a h_{CD} = P_{atm} + \rho g h_{BD}$

$\therefore\ a = g \times \frac{h_{BD}}{h_{CD}} = 10 \times \frac{25}{30} = 8.33\ m/s^2$

39. Ans: (c)

Sol:



$y_n = 0.5$ m

$q = 2\ m^3/s/m$

Rectangle : $y_c = \left(\frac{q^2}{g}\right)^{\frac{1}{3}}$

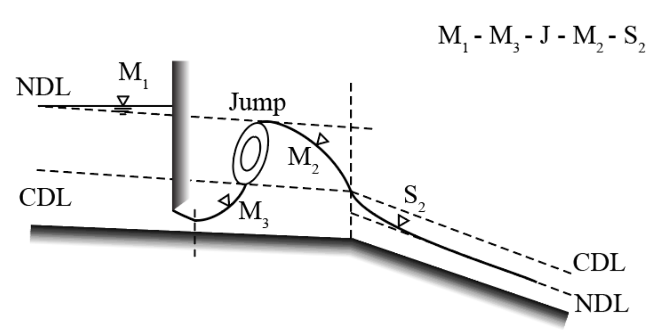
$= \left(\frac{2^2}{10}\right)^{\frac{1}{3}}$

$y_c = 0.74$ m

As NDL is below CDL, no profile would be formed on the upstream of drop, flow comes as uniform & meet the pool of water after the drop.

40. Ans: (b)

Sol:



41. Ans: (A)

Sol:

Sequent depths

$y_1 = 0.25$ m

$y_2 = 1.25$ m

$$\Delta E = \frac{(y_2 - y_1)^3}{4.y_1 y_2}$$

$$= \frac{(1.25 - 0.25)^3}{4 \times 1.25 \times 0.25}$$

$$= \frac{4}{5} = 0.8$$

42. Ans: (c)

Sol:

Same velocity, 'V' constant

$$h_f = \frac{fLV^2}{2gd}$$

$$\frac{h_f}{L} = \frac{f.V^2}{2gd}$$

For circular sewer running full

(or) $R = \frac{d}{4}$

$\therefore$ d = 4R

$$\therefore \frac{h_f}{L} = \frac{fV^2}{8gR}$$

Hydraulic radius for both running full and half is same. Head loss per unit length in both cases is same. So, the ratio is one.

43. Ans: (c)

Sol:

Average Boundary shear stress,

$\tau_o = \gamma_w R. S_o$, Assume $\gamma_w = 10$ kN/m^3

$$R = \frac{A}{P} = \frac{By}{B+2y} = \frac{2 \times 1.5}{2 + 2 \times 1.5} = \frac{3}{5}$$

$$\tau_o = 10 \times 10^3 \times \frac{3}{5} \times 0.0002$$

$$\tau_o = \frac{6}{5} = 1.2 \text{ N/m}^2$$

44. Ans: (b)

Sol:

Cipolleti weir flow rate is same as suppressed rectangle weir flow rate.

L = B $\rightarrow$ Base width

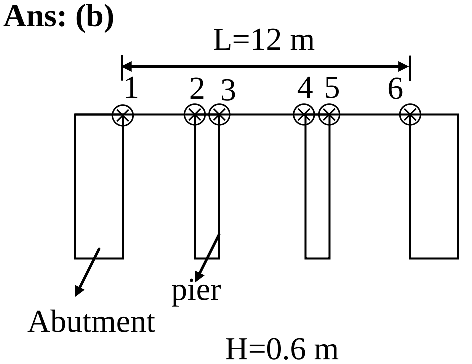
$$\therefore Q = \frac{2}{3} C_d \sqrt{2g}.L.H^{3/2}$$

$$\therefore K = \frac{2}{3} C_d \sqrt{2g}.B$$

$$= \frac{2}{3} \times 0.62 \times 4.4 \times B = 1.82 \text{ B}$$

45. Ans: (b)

Sol:



H=0.6 m

$\therefore$ Number of end contractions, n = 6

Due to end contractions, length reduces by 0.1 H for one contraction.

$L_{eff} = L - n \times 0.1H$ – width of piers

$= 12 - 6 \times 0.1 \times 0.6 - 2 \times 0.3$

$L_{eff} = 11.04$ m

46. Ans: (C)

Sol: For small errors < 5%

$$\frac{dQ}{Q} = n.\frac{dH}{H} \quad \text{for V - notch}$$

$$n = \frac{5}{2}$$

$$\frac{dQ}{Q}\times 100 = \frac{5}{2}\times\frac{dH}{H}\times 100$$

$$\therefore \frac{dQ}{Q} = \frac{5}{2}\times 4 = 10\%$$

47. Ans: (c)

48. Ans: (d)

Sol: Given, $\mu = 0.0014$ Ns/m^2

V = 0.2 m/sec,

Area of plate (A) = 0.15 m^2

Gap between the plates (y) = 0.0002 m

$$\tau = 0.0014 \times \frac{0.2}{0.0002} = 1.4\ \text{N/m}^2$$

Shear force = $\tau \times A$

= 1.4 × 0.15 = 0.21 N

Power required to maintain the flow

P = Shear force × velocity

= 0.21 × 0.2 = 0.042 W

49. Ans: (d)

Sol:

- When size of object is very large as compared to mean free path the continuum hypothesis is applicable.
- Continuum hypothesis does not talk about inter molecular forces.

50. Ans: (d)

Sol: $$h^* - \bar{h} = \frac{I_G \sin^2\theta}{A\bar{h}}$$

$$= \frac{\frac{\pi R^2}{8}\times 1}{\frac{\pi R^2}{2}\times R} = \frac{R}{4}$$

51. Ans: (b)

Sol: Required work = Increases in surface energy

$$= \sigma(A_2 - A_1) = \sigma\times\left(4\pi R_2^2 - 4\pi R_1^2\right)\times 2$$

$$= 8\pi\sigma\times\left[(2R)^2 - R^2\right]$$

$$= 24\pi\sigma R^2$$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52. Ans: (c)

Sol: $\nabla.\left(\rho\vec{V}\right)+\frac{\partial\rho}{\partial t}=\rho\nabla.\vec{V}+\vec{V}.\nabla\rho+\frac{\partial\rho}{\partial t}$

$$=\rho\nabla.\vec{V}+\frac{D\rho}{Dt}$$

Hence, both of the above equations are equivalent and both of them represent continuity equation in differential form.

53. Ans: (a)

Sol: $d\psi=\frac{\partial\psi}{\partial x}dx+\frac{\partial\psi}{\partial y}dy=vdx-udy$

$= 3x^2\,dx + 3y^2\,dy$

$\psi=\int 3x^2dx+\int 3y^2dy+C$

$\psi = x^3 + y^3 + C$

$\frac{Q}{b}=\left|\psi_2-\psi_1\right|$

where b is the width

$=\left|\left(1^3+2^3+C\right)-\left(0^3+0^3+C\right)\right| = 9\ m^2/s$

54. Ans: (b)

Sol: $a_r=u_r\frac{\partial u_r}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_r}{\partial\theta}-\frac{u_\theta^2}{2}+\frac{\partial u_r}{\partial t}$

$$=\left(-\frac{k}{r}\right)\frac{\partial}{\partial r}\left(-\frac{k}{r}\right)-\frac{\left(\frac{k}{r}\right)^2}{r}$$

$$=\left(-\frac{k}{r}\right)\left(\frac{k}{r^2}\right)-\frac{k^2}{r^3}$$

$$=-\frac{2k^2}{r^3}=-\frac{2k^2}{1^3}$$

$$=-2k^2$$

55. Ans: (a)

Sol: The kinetic energy correction factor is given as:

$$\alpha=\frac{\int u^3dA}{AV^3}$$

$$V=\frac{U_\infty+0}{2}=\frac{U_\infty}{2}$$

$u=\frac{U_\infty}{h}y=ky$ where $k=\frac{U_\infty}{h}$

A = bh

where, b = width perpendicular to plane of diagram.

$$\alpha=\frac{\int_0^h (ky)^3\ b\,dy}{(bh)\times\left(\frac{U_\infty}{2}\right)^3}$$

$$=\frac{8}{bhU_\infty^3}\times bk^3\times\left[\frac{y^4}{4}\right]_0^h$$

$$=\frac{2k^3}{hU_\infty^3}\times h^4$$

$$=2\times\frac{(kh)^3}{U_\infty^3}=2\frac{U_\infty^3}{U_\infty^3}=2$$

56. Ans: (b)

Sol: The jet performs projectile motion hence horizontal component of velocity (u) remains constant throughout. At topmost point, only horizontal component is present.

$\therefore V_2 = u = V_1 \cos\theta = 18 \times \cos 30° = 9$ m/s

By continuity equation,

$A_1V_1 = A_2V_2$

$$V_2 = \frac{A_1}{A_2}V_1 = \left(\frac{d_1}{d_2}\right)^2 V_1$$

$$d_2 = d_1\sqrt{\frac{V_1}{V_2}}$$

$$= 6\sqrt{2} = 8.49 \text{ cm}$$

57. Ans: (d)

Sol: By applying Bernoulli's equation between (1) and (2) along streamline passing through axis,

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

$$\frac{V_2^2 - V_1^2}{2g} = \frac{P_1 - P_2}{\rho g} - h_f = 0.2 - 0.05$$

i.e, $\frac{V_2^2 - V_1^2}{2g} = 0.15$ -----(i)

From continuity equation:

$A_1V_1 = A_2 V_2$

$$V_2 = \frac{A_1}{A_2}V_1 = \left(\frac{d_1}{d_2}\right)^2 V_1$$

$$= \left(\frac{10}{5}\right)^2 V_1 = 4V_1$$

$\therefore (4V_1)^2 - V_1^2 = 2 \times 10 \times 0.15$

$15 V_1^2 = 2\times10\times0.15$

$V_1^2 = 0.2$

$$V_1 = \sqrt{0.2\times10^4} = 20\sqrt{5} \text{ cm/s}$$

$Q = A_2 V_2$

$$= \frac{\pi}{4}\times 5^2 \times 20 \times \sqrt{5}$$

$$= 125\pi\sqrt{5} \text{ cm}^3\text{/s}$$

58. Ans: (c)

Sol: By angular momentum equation,

$$T = \frac{\rho Q}{2}V_1 r_1 + \frac{\rho Q}{2}V_2 r_2$$

$= \rho Q\ V_1\ r_1$ [$\because V_1 = V_2$ & $r_1 = r_2$ due to symmetry]

But T = 0

$\Rightarrow V_1 = 0$. Hence statement (1) is correct.

The discharge depends upon relative velocity of water with respect to nozzle.

$$V_{r1} = \frac{Q}{A} = \frac{0.5\times10^{-3}}{0.5\times10^{-4}} = 10 \text{ m/s}$$

Hence, statement (2) is also correct.

59. Ans: (d)

Sol: $h_f = \frac{\Delta P}{\rho g} = \frac{32\mu VL}{\rho g D^2} = \frac{128\mu QL}{\pi\rho g D^4}$

$h_f \propto D^{-4}$

Note: If Darcy-Weishach equation is used then the friction factor for laminar flow should be considered $\frac{64}{Re}$.

$\therefore\ h_f = \frac{f L V^2}{2gD} = \frac{64}{Re} \times \frac{LV^2}{2gD}$

$= \frac{64\mu}{\rho VD} \times \frac{LV^2}{2gD}$

$= \frac{32\mu VL}{\rho g D^2}$

$= \frac{128\mu QL}{\pi\rho g D^4}$

60. Ans: (b)

Sol: Let 'q' be the discharge in each of the smaller pipe and Q be discharge in bigger pipe.

$h_{f1} = h_{f2}$

$\frac{f L Q^2}{12.1 D^5} = \frac{f L q^2}{12.1\left(\frac{D}{2}\right)^5}$

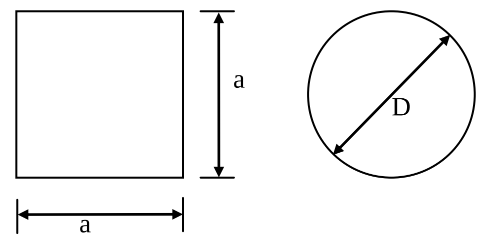
$q^2 = \frac{Q^2}{32}$

$q = \frac{Q}{4\sqrt{2}}$

$\frac{8q}{Q} = \frac{\left(\frac{8Q}{4\sqrt{2}}\right)}{Q} = \sqrt{2}$

61. Ans: (a)

Sol:



$D_h = \frac{4A_s}{P_s} = \frac{4 \times a^2}{4a} = a$

$A_S = A_C$

$a^2 = \frac{\pi}{4} D^2$

$a = \frac{\sqrt{\pi} D}{2}$

$\frac{h_{fs}}{h_{fc}} = \frac{f L V_s^2 / 2gD_h}{f L V_c^2 / 2gD}$

$= \left(\frac{V_s}{V_c}\right)^2 \times \left(\frac{D}{D_h}\right)$

$= \left(\frac{Q_s}{A_s}\right)^2 \times \left(\frac{A_c}{Q_c}\right)^2 \times \frac{D}{a}$

$= \frac{2}{\sqrt{\pi}}$ [$\because Q_s = Q_c$ and $A_s = A_c$]

62. Ans: (b)

Sol: Sum of discharges at a junction is zero. Sum of discharges around a loop may not be zero.

63. Ans: (a)

Sol: The ball will be retarded after the impact due to drag force exerted by air.

$$a = -\frac{F_D}{m} = -\frac{C_D}{2}\frac{\rho A V_\infty^2}{m}$$

$$= -\frac{0.5}{2} \times \frac{1.2 \times \pi \times 0.02^2 \times 30^2}{3 \times 10^{-3}}$$

$= -36\pi$ m/s^2

64. Ans: (b)

Sol:

- Strouhl number $\left(St = \frac{f\,D}{U_\infty}\right)$ is related to flow induced vibrations.
- Knudsen number $\left(Kn = \frac{\lambda}{L}\right)$ is used to verify validity of continuum hypothesis.
- Mach number $\left(Ma = \frac{V}{C}\right)$ is related to water hammer.
- Thoma's number $\left(\sigma = \frac{NPSH}{H}\right)$ is related to cavitation.

65. Ans: (d)

Sol: For linear velocity profile, $\frac{u}{U_\infty} = \frac{y}{\delta}$

$$\theta = \int_0^\delta \frac{u}{U_\infty}\left(1 - \frac{u}{U_\infty}\right)dy = \int_0^\delta \frac{y}{\delta}\left(1 - \frac{y}{\delta}\right)dy$$

Let $\frac{y}{\delta} = \eta$,

$\therefore$ dy = δdη, at y = 0, η = 0 and at y = δ, η = 1.

$$\theta = \delta\int_0^1 \eta(1-\eta) = \int_0^1 (\eta - \eta^2)d\eta$$

$$\frac{\theta}{\delta} = \left[\frac{\eta^2}{2} - \frac{\eta^3}{3}\right]_0^1$$

$$\frac{\theta}{\delta} = \left[\frac{1}{2} - \frac{1}{3}\right] = \frac{1}{6}$$

66 Ans: (a)

Sol: **True meridian:** It is the great circle passing through the point under consideration, geographic north and south poles of the earth. It is constant and does not change with time.

Magnetic meridian: It is the direction indicated by a freely suspended balanced magnetic needle. It is affected by magnetic disturbances and is not constant w.r.t time.

Magnetic bearing: It is the horizontal angle which a line makes with magnetic meridian.

Since magnetic meridian changes from time to time, magnetic bearing also changes and is not fixed.

67. Ans: (a)

Sol: **True meridian:** It is the great circle passing through the point under consideration, geographic north and south poles of the earth. It is constant and does not change with time.

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Magnetic bearing: It is the horizontal angle which a line makes with magnetic meridian.

Since magnetic meridian changes from time to time, magnetic bearing also changes and is not fixed.

68. Ans: (d)

Sol: If the point 'P' lies on the great circle passing through the points A, B, C then the position of point 'P' cannot be determined from three point problem since the problem becomes indeterminate as the three rays will always intersect at a point irrespective of orientation of plane table.

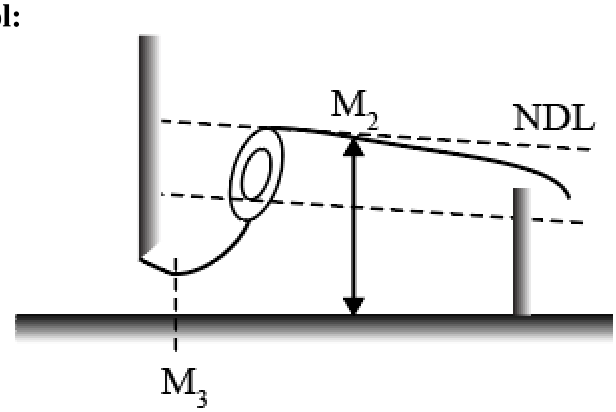
69. Ans: (a)

Sol: In rise and fall method, difference between levels of consecutive staff points is calculated. Used when a lot number of intermediate stations are employed. This ensures check on reduced levels of intermediate stations.

Note: Height of instrument method is suitable if there are no intermediate stations.

70. Ans: (d)

Sol:



$y_1 \rightarrow$ pre jump depth

$y_2 \rightarrow$ post jump depth

If there exists a short reach of channel on down stream side of sluice, with a free overfall (or) abrupt drop in mild channel, there will be a M_2 profile developed, after the formation of jump depth of flow will be gradually varying and sequent depth will lie along the M_2 profile but not remain as normal depth of flow.

71. Ans: (d)

Sol: The maximum head is developed by the centrifugal pump when discharge through pump is zero. At this condition efficiency of the pump is also zero.

72. Ans: (a)

Sol: As Kaplan turbine blades are adjustable, they can be adjusted according to discharge in such a way that the relative velocity is tangential to the blade. This ensures the flow enters shock free even at part load.

73. Ans: (d)

Sol: TEL always falls in the direction of flow because energy of fluid decreases due to various losses but HGL may rise or fall depending upon whether velocity is decreasing or increasing in the flow passage.

74. Ans: (a)

Sol: In water hammer phenomenon, the conversion of kinetic energy into strain energy of compressed liquid is responsible for pressure rise. If pipe is elastic then some part of kinetic energy is converted into strain energy of pipe. Hence liquid pressure rise is less.

75. Ans: (d)

Sol: Velocity gradient in normal direction is high due to reason explained in statement (II). The meaning of statement (I) is exactly opposite.