Mock Test 3

Number of Questions: 65 **Total Marks: 100**

Section – I: General Aptitude

Questions 1 to 5 carry One Mark each.

Directions for question 1: Select the correct alternative from the given choices.

1. In a UG and PG College with a total strength of 1000, 26% of the students are girls. There are 520 PGs and 38 more male UGs than female UGs. What percent of the males are UGs?
(A) 45%
(B) 65%
(C) 26%
(D) 35%

Directions for question 2: In the question below, there is a main statement followed by four statements *a*, *b*, *c* and *d*. From the choices, choose the ordered pair where the first statement implies the second statement and the two are logically consistent with the main statement.

2. Unless the Indian government seals the borders illegal migration in India will not stop.
a. Indian government sealed the border.
b. Illegal migration in India stopped.
c. Indian government had not sealed the borders.
d. Illegal migration in India will not stop.
(A) *cd* (B) *ab*
(C) *cb* (D) *ad*

Directions for question 3: In the question below, determine the relationship between the pair of capitalised words and then select the pair of words which has a **similar** relationship to the capitalized words and mark the number of that pair as your answer.

3. BEAVER : INDUSTRIOUS
(A) Dog : Watchful
(B) Hyena : Frightening
(C) Vixen : Waiting
(D) Fox : Cunning

Directions for question 4: In the given sentence select the correct alternative that best explains the meaning of the **idiom** from the given choices.

4. The leader of the opposition party had an axe to grind against the *CM* ever since he lost the elections.
Here 'axe to grind' means
(A) a damaging condemnation.
(B) an authoritative air.
(C) having a selfish motive for doing something.
(D) an official disgrace.

Directions for question 5: Identify the underlined part that has an error (of grammar usage, word choice or idiom) and write the number of that underlined part as your answer.

5. In this special meeting, many individuals
(A) (B)
as well as some groups has participated.
(C) (D)

Questions 6 to 10 carry Two Marks each.

Directions for questions 6 to 8: Select the correct alternative from the given choices.

6. The terrorist attacks in Mumbai has raised security concerns. These attacks have raised serious doubts about the safety of the residents of Mumbai.
Which of the following can be an **inference** drawn from the above statements? (An inference is something which is not directly stated but can be inferred from the given facts)
(A) Terrorists attacked common citizens.
(B) Terrorist attacked a province of high importance.
(C) The residents of Mumbai are shifting to other cities.
(D) None of these

7. If ℓ, m and n are distinct and $\ell^a = m^b = n^c = \ell mn$, then $ab + bc + ca =$
(A) $(a+b+c)^2$ (B) $a(b+c)$
(C) abc (D) $abc(a+b+c)$

8. A can complete a job $2\frac{1}{2}$ times as big as job X in 25 hours. B can complete a job $3\frac{1}{2}$ times as big as X in 42 hours. C can complete a job $4\frac{1}{2}$ times as big as X in 49 $\frac{1}{2}$ hours. D can complete the job $5\frac{1}{2}$ times as big as X in $54\frac{9}{20}$ hours. Who is the most efficient among the four?
(A) D (B) C
(C) B (D) A

Directions for question 9: In the following question statements 1 and 6 are respectively the first and the last sentences of a paragraph and statements (2), (3), (4) and (5) come in between them. Rearrange (2), (3), (4) and (5) in such a way that they make a coherent paragraph together with statements 1 and 6. Select the correct order from the given choices and mark its number as your answer.

9. (1) strology is considered to be one of the six limbs of the Vedas.

(2) Astrology's inclusion as a subject in universities is not a retrograde step and certainly doesn't deserve to be derided.
(3) It will create a sensation in the West like yoga – ridiculed by pseudo secularists here but assimilated by the Europeans and Americans – did.
(4) Astrology attempts to interpret the influence of heavenly bodies on human affairs.
(5) It is, in fact, a pragmatic measure considering that our society is misguided by some unscrupulous elements in the garb of astrologers who have no basic understanding of the subject.
(6) Incidentally, when a dead subject like Marxism can continue to be taught, why not astrology in which a vast majority of Indians have faith?

(A) 2453
(B) 4253
(C) 2345
(D) 4352

Directions for question 10: Select the correct alternative from the given choices.

10. Cases of food poisoning have been reported from village '*X*'. After a dinner party arranged for 100 people, 68 have been admitted to the hospital, 36 cases are reported to be out of danger. The food, which was cooked and stored in an open space for almost 12 hours earlier was served after reheating it. Investigation is going on. A news report.
Which of the following can be hypothesized from the above information?
(A) Late night dinner parties for large number of people result into food poisoning.
(B) Stale food is likely to be the cause of food poisoning.
(C) Cases of food poisoning need to be handled carefully.
(D) Food poisoning is a matter of chance and no preventive measure can be suggested.

SECTION – II: CIVIL ENGINEERING

Directions for questions 11 to 65: Select the correct alternative form the given choices.

Questions 11 to 35 carry One Mark each.

11. By changing the order of integration, the double integral $\int_{-1}^{1}\int_{x-1}^{1-x} f(x, y)dxdy$ changes to _____.

(A) $\int_{-1}^{1}\int_{1+y}^{1-y} f(x, y)dxdy$

(B) $\int_{-1}^{0}\int_{1+y}^{1-y} f(x, y)dxdy$

(C) $\int_{0}^{1}\int_{1+y}^{1-y} f(x, y)dxdy$

(D) $\int_{-1}^{0}\int_{0}^{1+y} f(x, y)dxdy + \int_{0}^{1}\int_{0}^{1-y} f(x, y)dxdy$

12. The solution of the differential equation $\frac{dy}{dx}+\frac{2x}{y} = 0$; $y(0) = 2$ at $x = 0.1$ obtained by the Runge-Kutta method of second order with step size 0.1 is _____.

(A) 1.995 (B) 2.005
(C) 1.905 (D) 2.01

13. The value of $\int_{-\infty}^{-2} \frac{20}{x^6} dx$ is _____.

(A) $\frac{1}{4}$ (B) $\frac{1}{8}$
(C) $\frac{1}{16}$ (D) $\frac{7}{8}$

14. If the trace of a 3×3 matrix A with all of its eigenvalues being one and the same is $\frac{15}{2}$, then the determinant of A is _____.

(A) $\frac{125}{4}$ (B) $\frac{25}{4}$
(C) $\frac{125}{8}$ (D) $\frac{25}{8}$

15. The partial differential equation of $z = e^y f(x^2 - y^2)$ is _____.

(A) $zx = py + qx$ (B) $zy = px + qy$
(C) $zx = py - qx$ (D) $zy = px - qy$

16. A rapid test to indicate the intensity of pollution in river water is_____

(A) *BOD* (B) *DO*
(C) *MPN* (D) *TDS*

17. The unit in which both sedimentation and digestion processes of sludge takes place simultaneously is ____

(A) Skimming tank (B) Imhoff tank
(C) Deritus tank (D) Digestion tank

18. Modulus of elasticity of concrete is _____

1. Tangent Modulus
2. Secant Modulus
3. Proportional to $\sqrt{fck}$
4. Proportional $\frac{1}{\sqrt{fck}}$

Which of these statements are correct?

(A) 1 and 3 only (B) 1 and 4 only
(C) 2 and 3 only (D) 2 and 4 only

19. The timber preservative "Creosote" belongs to group of
(A) Water soluble salts (B) Inorganic solvent
(C) Tar oil (D) Organic solvent

20. Minimum clear cover (in mm) to the main steel in slab, beam, column are respectively _____
(A) 15,25 and 40 (B) 20, 25 and 30
(C) 20,35 and 50 (D) 10,15 and 25

21. If optimistic, pessimistic and expected times of an activity are given as 8, 16 and 12 days respectively, find the most probable time of the given activity?
(A) 16 days (B) 12 days
(C) 8 days (D) 10 days

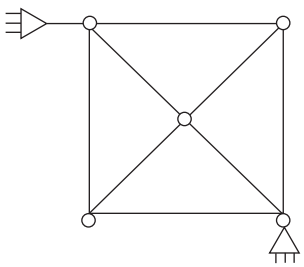
22. The maximum longitudinal pitch in bolted joints, subjected to tensile forces, (Where t – thickness of the plate and D – diameter of the bolt)
(A) 32D (B) 16D
(C) 32t (D) 16t

23. If the gross bearing capacity of a strip footing of 1.2 m wide located at a depth of 2 m in a clay is 340 kN/m^2, its net bearing capacity for $\gamma = 20$ kN/m^3 is_____ (in kN/m^2)
(A) 250 (B) 300
(C) 350 (D) 400

24. Which of the following statements below are correct?
(i) Vibratory rollers are best suited for compacting sandy soil.
(ii) Relative compaction is the same as relative density.
(iii) Zero air void line and 100% saturation line are identical.
(A) (i), (ii), (iii) are correct
(B) (i) and (iii) are correct
(C) (i) and (ii) are correct
(D) (ii) and (iii) are correct

25. A concentrated load of 500 kN acts vertically at a point on the soil surface. According to Boussinesq's equation the ratio of the vertical stresses at a depth of 2 m and 4 m is_____
(A) 0.5 (B) 0.25
(C) 2 (D) 4

26. The static indeterminacy of the truss shown below is___



(A) 0 (B) 1
(C) 2 (D) 3

27. Consumptive use refers to loss of water as a result of
(A) Evaporation and transpiration.
(B) Crop water requirement.
(C) Evaporation and Infiltration.
(D) Evaporation and transpiration from cropped area.

28. Garret's diagrams are used to
(A) Separate base flow from total run off.
(B) Correct inconsistency in rainfall data.
(C) Determine reservoir capacity.
(D) Design channels.

29. "Isogonic lines" passes through points of
(A) Zero declination (B) Equal declination
(C) Equal dip (D) None of above

30. Which of the following closely represents the shape of the earth.
(A) Spheroid (B) Ellipsoid
(C) Oblate spheroid (D) Oblate ellipsoid

31. The consistency and flow resistance of bitumen can be determined from the following
(A) Ductility test (B) Penetration test
(C) Softening point test (D) Viscosity test

32. A velocity potential function is given by $\phi = 3xy$. x and y components of velocity at point (1, 2) is
(A) 3, 6 (B) 6, 3
(C) –3, –6 (D) –6, –3

33. In a pipe of 300 mm diameter and 700 m length an oil of specific gravity 0.8 is flowing at the rate of 0.45 m^3/s. If coefficient of friction is 0.00498, head loss due to friction (in m) of oil is
(A) 96 (B) 115
(C) 124 (D) 136

34. For viscous flow through pipe, Darcy-Weisbach friction factor in terms of Reynold's number R_e is given by
(A) $\frac{16}{R_e}$ (B) $\frac{32}{R_e}$
(C) $\frac{48}{R_e}$ (D) $\frac{64}{R_e}$

35. State of stress at a point in a stressed body are, $\sigma_x = 900$ MPa, $\sigma_y = 300$ MPa, $\tau_{xy} = 400$ MPa. Radius of the circle representing this state of stress is
(A) 300 MPa (B) 400 MPa
(C) 500 MPa (D) 600 MPa

Questions 36 to 65 carry Two Marks each.

36. The directional derivative of $f(x, y, z) = x\ell nz - y^2 + 40$ at (−1, 2, 1) in the direction of the normal to the surface $4x^2y + z^3 = 4$ at (1, −1, 2) is _____.
(A) $\sqrt{\frac{7}{2}}$ (B) $\frac{7}{\sqrt{2}}$
(C) $-\sqrt{\frac{7}{2}}$ (D) $\frac{-7}{\sqrt{2}}$

37. If A and B are two events of the sample space S such that $P(B) = \frac{3}{5}$ and $P(A' \cap B') = \frac{1}{6}$ (where E' denote the complement of an event E), then $P\left(\frac{A}{B'}\right)$ is _____.

(A) $\frac{7}{12}$ (B) $\frac{2}{3}$

(C) $\frac{3}{4}$ (D) $\frac{5}{12}$

38. Which of the following functions is/are continuous at $x = 2$? (Here $[x]$ denotes the greatest integer less than or equal to x).

I. $f(x) = \begin{cases} 3x - [x]; & \text{if } x < 2 \\ 5 \quad ; & \text{if } x = 2 \\ x + 3 \; ; & \text{if } x > 2 \end{cases}$

II. $g(x) = \begin{cases} \frac{x^2 + 2x - 8}{x^2 + 3x - 10}; & \text{if } x \neq 2 \\ \frac{5}{7} \quad ; & \text{if } x = 2 \end{cases}$

(A) I only (B) II only

(C) Both I and II (D) Neither I nor II

39. If A is a real matrix of order 3×3 with trace -1 and $-2 - 5i$ as one of the eigenvalues, then the determinant of A is _____.

(A) 63 (B) −63

(C) 87 (D) −87

40. The Laplace transform of the solution of the initial value problem

$\frac{d^2x}{dt^2} + 5\frac{dx}{dt} - 14x = 0$; $x(0) = 1$ and $\left(\frac{dx}{dt}\right)_{at\ t=0} = 2$

is _____.

(A) $\frac{1}{s-2}$ (B) $\frac{1}{s+7}$

(C) $\frac{s+2}{s^2+5s-14}$ (D) $\frac{s-7}{s^2+5s-14}$

41. A slender column is fixed at one end and the other end is hinged. Euler's buckling load and effective length respectively are.

(A) $\frac{\pi^2 EI}{\ell^2}, \ell$ (B) $\frac{2\pi^2 EI}{\ell^2}, \frac{\ell}{\sqrt{2}}$

(C) $\frac{4\pi^2 EI}{\ell^2}, \frac{\ell}{2}$ (D) $\frac{\pi^2 EI}{4\ell^2}, 2\ell$

42. A mild steel flat subjected to tensile force of 84 tonnes is connected to a gusset plate using rivets. If the force required to sheer a single rivet, to crush the rivet and to tear the plate per pitch length are 5000 Kg, 8000 kg and 6000 kg respectively; then the number of rivets required is _____

(A) 12 (B) 14

(C) 16 (D) 17

43. For a fixed beam with a concentrated load W at $\frac{1}{4}$ th of span from an end; the collapse load is _____

(A) $\frac{16\ Mp}{3L}$ (B) $\frac{4\ Mp}{L}$

(C) $\frac{32\ Mp}{3L}$ (D) $\frac{6\ Mp}{L}$

44. Consider the singly reinforced beam section with following parameters. Calculate the moment of resistance by Limit state method?

Grade of concrete used: M30

Reinforcement: 5 No's of Fe 415 having dia of 16 mm

Cross section: 200 mm × 350 mm

Effective cover: 25 mm

(A) 73 KN-m (B) 87 KN-m

(C) 93 Kw-m (D) 112 KN-m

45. Results of a water sample analysis are as follows.

Cation	Concentration (mg/l)	Equivalent weight
Na^+	40	23
Mg^{+2}	10	12.2
Ca^{+2}	55	20
K^+	12	39

Hardness of the water sample in mg/L as $CaCO_3$ is ___

(A) 44.8 (B) 89.5

(C) 179 (D) 358

46. A landfill is to be designed to serve a population of 2,00,000 for a period of 20 years. The solid waste (SW) generated is 2.5 Kg/person/day. The density of un-compacted SW is 100 Kg/m^3 and a compaction ratio of 4 is recommended. The ratio of compacted fill (i.e; SW + cover) to compacted SW is 1.5. The landfill volume (in million m^3) required is _____

(A) 10.6 (B) 11.6

(C) 12.7 (D) 13.7

47. Two Electro static precipitators (ESPS) are in series. The fractional efficiencies of the up stream and down stream ESPS for a size dp are 80% and 65%, respectively. What is the overall efficiency of the system for the same *dp*?

(A) 100% (B) 93%

(C) 80% (D) 65%

48. A sample of dry soil weighs 50 gm. Find the volume of voids (in ml) if the total volume of the sample is 50 ml and the specific gravity of solids is 2.65.

(A) 31.5 (B) 25.2

(C) 15.4 (D) 42.1

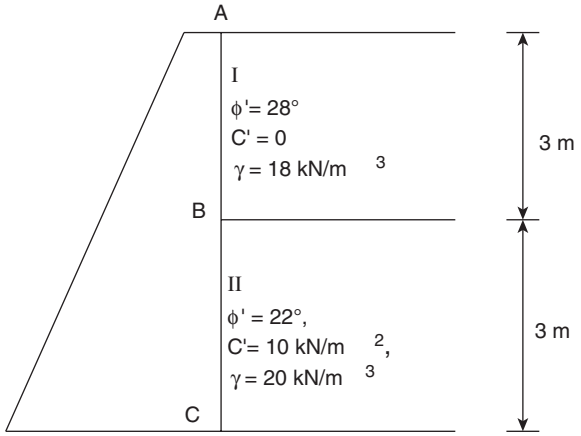
49. The consistency limits of a soil sample are;
Liquid limit = 40%
Plastic limit = 25%
Shrinkage limit = 5%.
If the specimen of this soil shrinks from a volume of 7.5 cm^3 at liquid limit to 4.5 cm^3 at the shrinkage limit, the specific gravity of soil solids is _____
(A) 2.25 (B) 2.75
(C) 2.10 (D) 2.02

50. In a consolidation test on a soil, the void ratio of the sample decreased from 1.25 to 1.10 when the pressure is increased from 250 kN/m^2 to 450 kN/m^2. The coefficient of consolidation of soil if the coefficient of permeability is 8×10^{-8} cm/sec is ____ (m^2/year).
(A) 6.7 (B) 7.7
(C) 8.7 (D) 9.7

51. A shear vane, 7.5 cm dia and 11.25 cm long, was pressed into soft clay at the bottom of a bore hole. The shear strength of clay if the torque required for failure was 50 N-m is____(in kN/m^2)
(A) 25 (B) 40
(C) 50 (D) 65

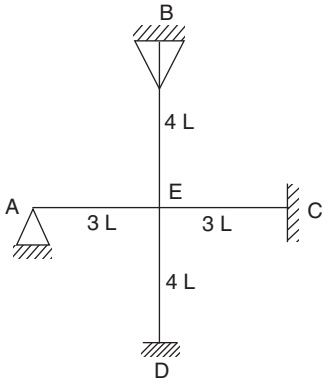
52. A long natural slope in an over consolidated clay (C' = 12 kN/m^2, ϕ' = 30°, γ_{sat} = 21 kN/m^3) is inclined at 10° to the horizontal. The water table is at the surface and the seepage is parallel to the slope. The factor of safety of slope at a depth of 5 m below the slope is_____ (take γ_w = 10 kN/m^3).
(A) 2.12 (B) 2.38
(C) 3.72 (D) 4.24

53. The retaining wall with backfill conditions are shown in below figure. The total passive force at bottom of the wall is____ (Take water table at level of B and γ_w = 10 kN/m^3).



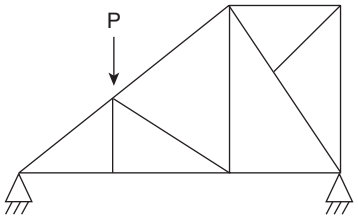
(A) 815 kN
(B) 755 kN
(C) 635 kN
(D) 952 kN

54. Distribution factor for DE in given figure is



(A) $\frac{12}{49}$ (B) $\frac{3}{13}$
(C) 1 (D) $\frac{49}{48}$

55. The number of Zero force members in the truss shown below is____



(A) 3 (B) 4
(C) 5 (D) 6

56. The following rainfall data refers to station A and B which are equidistant from station X

Long term	A	x	B
Normal Annual rainfall in mm	200	250	300
Annul rainfall in mm for the year 1940	140	P	270

The value of P will be.
(A) 250 (B) 220
(C) 205 (D) 200

57. A direct runoff hydrograph due to isolated storm was triangular in shape with a base of 80 h and peak of 200 m^3/s. If the catchment area is 1440 km^2, the effective rainfall of the storm is
(A) 20 cm (B) 10 cm
(C) 5cm (D) 2 cm

58. What is the maximum length of an offset so that the displacement of a point on the paper should not exceed 0.25 mm, gives that maximum error expected is 2.5° from its true direction and the scale is 1 : 2000
(A) 11.46 m (B) 1.48 m
(C) 14.32 m (D) 9.82 m

59. It is required to set up points on a sloping down ground of line 50 m at every 20 m contour interval. If the staff

reading over first point is 0.55 m. The staff reading over next point *B* is

(A) 0.95 m (B) 0.15 m
(C) 1.05 m (D) 0.25 m

60. Sliding considerations for stopped vehicle on super elevation. Horizontal curve provide the following bound on amount of super elevation.

(A) $e >$ coefficient of rolling friction
(B) $e >$ coefficient of side friction.
(C) $e >$ coefficient of rolling friction.
(D) $e >$ coefficient of side friction.

61. A vertical summit curve is formed at the intersection two gradients +3% and –6%. Design sped of two lane two way is 80 kmph. Driver reaction time is 2.5 sec. Over the curve to stop the vehicle frictional coefficient between road and tyres is 0.35. Then the length of the summit curve based on *SSD* is

(A) 296 m (B) 1182m
(C) 73.6 m (D) 1472 m

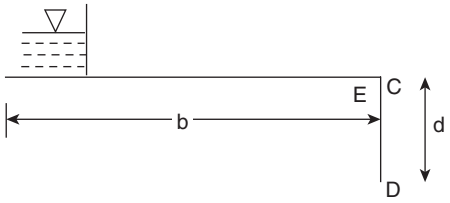
62. Consider the following factors:

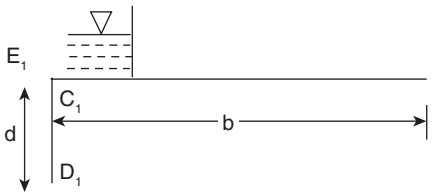
1. Reaction time
2. Speed
3. Coefficient of longitudinal fraction
4. Gradient

Which of these factors are taken into account for computing braking distance?

(A) 1 and 3 (B) 1, 2 and 4
(C) 2, 3 and 4 (D) 2 and 3

63. The uplift pressure at points *E* and *D* of a straight horizontal floor of negligible thickness with a sheet pile at down stream end are 30% and 40% respectively. If the sheet pile is at upstream end of floor the uplift pressure at point D_1 and C_1



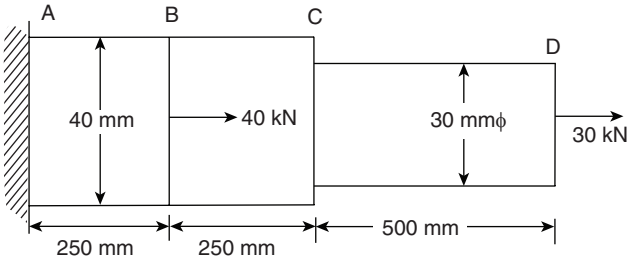


(A) 68% and 60% respectively
(B) 80% and 72% respectively
(C) 70% and 60% respectively
(D) 40% and 80% respectively

64. In a smooth inclined pipe of 250 mm diameter carrying water, point 2 is at a higher elevation of 2 m from point 1. Velocity through the pipe is 1.25 m/s. Pressures at points 1 and 2 are 50 kPa and 20 kPa respectively. Rate of flow (in m^3/s) through the pipe and direction of flow are

(A) 0.0614, upwards
(B) 0.0614, downwards
(C) 0.0307, upwards
(D) 0.0307, downwards

65.



In the composite bar as shown above portion *AC* is made of steel and portion *CD* is made of copper. The two materials are rigidly joined at *C*. Modulus of elasticities of steel and copper are 2×10^5 N/mm^2 and 1.1×10^5 N/mm^2 respectively. If the bar is loaded as shown in the figure, total extension produced in mm is _____.

(A) 0.2 mm
(B) 0.3 mm
(C) 0.4 mm
(D) 0.5 mm

Answer Keys

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

Hints and Explanations

1. The data is tabulated below

	Girls	Boys	Total
PG	39	481	520
UG	221	259	480
Total	260	740	1000

Percentage of males who are UG's is

$\frac{259}{740}\times 100 = 35\%$. Choice (D)

2. p

Unless [The Indian government seals the borders,]

q

[illegal migration will not stop.]

The implications of the above statement will

(i) $\sim p \Rightarrow q$ and

(ii) $\sim q \Rightarrow p$.

It can be CD or BA. Choice (A)

3. A 'beaver's' nature is to be 'industrious' (hard working). Among all the options, D is the correct one since 'cunning' is the nature of a fox. A dog is 'faithful' and being watchful is its secondary trait. A Hyena is not necessarily frightening. 'Vixen' (a female fox) and 'waiting' are unconnected. Choice (D)

4. When someone has 'an axe to grind' against someone or something, it means he/she has a 'false grievance' or a selfish motive for doing something. Choice (C)

5. The reference is the 'some groups' (in the plural). Hence, 'has' is erroneous and should be replaced with 'have' as the subject is a plural one. Choice (D)

6. No information is given whom the terrorists targeted. Hence, neither (A) nor (B) can be inferred. It cannot be inferred that the residents are moving out of Mumbai. Hence (C) cannot be inferred. Hence, none can be inferred. Choice (D)

7. Let $\ell^a = m^b = n^c = lmn = \lambda$

$\ell = \lambda^{\frac{1}{a}}$, $m = \lambda^{\frac{1}{b}}$ and $n = \lambda^{\frac{1}{c}}$

$\ell mn = (\lambda)^{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}}$

$\lambda^1 = \lambda^{\frac{ab+bc+ca}{abc}}$

$\Rightarrow \quad \frac{ab+bc+ca}{abc} = 1 \Rightarrow ab + bc + ca = abc.$

Choice (C)

8. Times in which A, B, C and D can complete 'X' (in hours) are $\frac{25}{2\frac{1}{2}}, \frac{42}{3\frac{1}{2}}, \frac{49\frac{1}{2}}{4\frac{1}{2}}$ and $\frac{54\frac{9}{20}}{5\frac{1}{2}}$ respectively.

$\frac{25}{2\frac{1}{2}} = \frac{25}{2.5} = 10$; $\frac{42}{3\frac{1}{2}} = \frac{42}{3.5}$ which is > 10.

Similarly it follows that $\frac{49\frac{1}{2}}{4\frac{1}{2}} > 10$ and $\frac{54\frac{9}{20}}{5\frac{1}{2}} < 10$

$\therefore$ D would take the least time to complete the job.

$\therefore$ D is the most efficient. Choice (A)

9. It would be more appropriate for statement (4) to follow statement 1 because it explains the function of "astrology" which has been introduced in the previous sentence. (4) cannot be followed by (3) because of the future tense in 'it will'. Choice (B)

10. The report says that 68 out of 100 people were admitted to the hospital because of the food poisoning. The most appropriate cause, which is stated in the statements, is stale food. Choice (B)

11. Given double integral is <<Eqn3767.eps>>= I, (say)

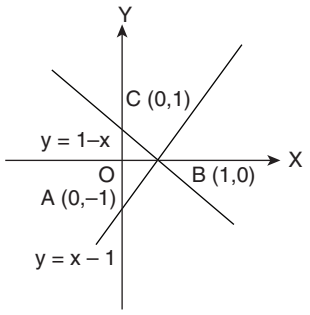
Here y varies from $y = x - 1$ to $y = 1 - x$

And x varies from $x = 0$ to $x = 1$

$\therefore$ The region of integration is the triangle ABC as shown in the figure.

By changing the order of integration, the given integral becomes,

$$I = \iint_{OAB} f(x, y)dxdy + \iint_{OBC} f(x, y)dxdy \quad \rightarrow (I)$$



Where in triangle OAB, x varies from $x = 0$ to $x = 1 + y$ and y varies from $y = -1$ to $y = 0$

And in triangle OBC,

x varies from $x = 0$ to $x = 1 - y$

and y varies from $y = 0$ to $y = 1$

$\therefore$ By changing the order of integration, we have

$$I = \int_0^1 \int_{x-1}^{1-x} f(x, y)dxdy = \int_{-1}^0 \int_0^{1+y} f(x, y)dxdy$$

$$+ \int_0^1 \int_0^{1-y} f(x, y)dxdy$$ Choice (D)

12. Given differential equation is $\frac{dy}{dx}+\frac{2x}{y}=0; y(0)=2$

$\Rightarrow \quad \frac{dy}{dx}=\frac{-2x}{y}$

$\therefore \quad f(x,y)=\frac{-2x}{y}; h=0.1;$

$x_0=0; y_0=y(0)=2$

By Runge-Kutta method of second order, we have

$$y_1=y_0+\frac{1}{2}[k_1+k_2] \qquad \rightarrow (1)$$

where $k_1=hf(x_0,y_0)$

$$=h\left(\frac{-2x_0}{y_0}\right)=(0.1)\left(\frac{-2\times 0}{2}\right)$$

$\therefore \quad k_1=0$

and $k_2=hf(x_0+h, y_0+k_1)$

$$=h\left(\frac{-2(x_0+h)}{y_0+k_1}\right)=(0.1)\left(\frac{-2(0+0.1)}{2+0}\right)$$

$k_2=-0.01$

$\therefore$ Substituting these in (1), we get

$$y_1=y(0.1)=2+\frac{1}{2}[0+(-0.01)]$$

$$=1.995$$ Choice (A)

13. We have $\int_{-\infty}^{-2}\frac{20}{x^6}dx=\underset{A\to\infty}{Lim}\int_{-A}^{-2}\frac{20}{x^6}dx$

$$=\underset{A\to\infty}{Lim}\frac{20}{-5x^5}\Big]_{-A}^{-2}$$

$$=\underset{A\to\infty}{Lim}\left[\frac{20}{-5(-2)^5}-\frac{20}{-5(-A)^5}\right]$$

$$=\underset{A\to\infty}{Lim}\left[\frac{1}{8}-\frac{4}{A^5}\right]=\frac{1}{8}-0=\frac{1}{8}$$ Choice (B)

14. Let λ be an eigenvalue of A.

$\therefore$ Trace of $A=\frac{15}{2}$

$\Rightarrow \quad \lambda+\lambda+\lambda=\frac{15}{2}$ ($\because$ Trace of A = Sum of the eigenvalues of A)

$\Rightarrow \quad \lambda=\frac{5}{2}$

$\therefore$ The determinant of A = Product of the eigenvalues of $A=\lambda\times\lambda\times\lambda=\lambda^3$

$$=\left(\frac{5}{2}\right)^3=\frac{125}{8}$$ Choice (C)

15. Given $z=e^y f(x^2-y^2)$ $\rightarrow (1)$

$\Rightarrow \quad f(x^2-y^2)=\frac{z}{e^y}$ $\rightarrow (2)$

Differentiating (2) *w.r.t* x partially,

$$f'(x^2-y^2).2x=\frac{1}{e^y}\frac{\partial z}{\partial x}$$

$\Rightarrow \quad 2x.f'(x^2-y^2)=\frac{p}{e^y}$ $\rightarrow (3)$

Differentiating (2) w.r.t y partially

$$f'(x^2-y^2)(-2y)=\frac{e^y\frac{\partial z}{\partial y}-ze^y}{(e^y)^2}$$

$\Rightarrow \quad -2yf'(x^2-y^2)=\frac{q-z}{e^y}$ $\rightarrow (4)$

$$\frac{(3)}{(4)}\Rightarrow\frac{2xf\left(x^2-y^2\right)}{-2yf\left(x^2-y^2\right)}=\frac{\frac{p}{e^y}}{\frac{(q-z)}{e^y}}$$

$\Rightarrow \quad \frac{-x}{y}=\frac{p}{q-z}$

$\Rightarrow \quad -qx+zx=py$

$\Rightarrow \quad zx=py+qx$

$\therefore$ The partial differential equation of (1) is

$zx=py+qx$ Choice (A)

16. Total dissolved solids, TDS indicates the intensity of the pollution in a rapid manner. Choice (D)

17. Imhoff tank Choice (B)

18. $E_c=5000\sqrt{fck}$ and it is secant modulus

Choice (C)

19. Creosote belongs to group of " Tar oil" Choice (C)

20. Min clear cover for slabs, beams, columns, and footings are 15mm, 25mm, 40mm and 50mm respectively.

Choice (A)

21. $t_O=8$ days

$t_p=16$ days

$t_e=12$ days

$$t_e=\frac{t_0+4t_m+t_p}{6}=\frac{8+4(t_m)+16}{6}=12$$

$\therefore \quad t_m=12$ days. Choice (B)

22. The maximum longitudinal pitch in tension $16t$ or 200mm, whichever is less and in compression is $12t$ or 200mm which ever is less. Choice (D)

23. $q_n=q_u-\gamma.D=340-20\times 2=300\ \text{kN/m}^2$

Choice (B)

24. Statement (i) and (iii) are correct. Choice (B)

25. $\frac{(\sigma_z)_1}{(\sigma_z)_2}=\frac{(Z_2)^2}{(Z_1)^2}=\frac{4^2}{2^2}=\frac{4\times 4}{4}=4.$ Choice (D)

26. $D_s=(m+r)-2j=(9+4)-2\times 6=13-12$

$D_s=1$ Choice (B)

32. For potential function

$$u = \frac{-\partial\phi}{\partial x} \text{ and}$$

$$v = \frac{-\partial\phi}{\partial y}$$

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

$$\text{and } v = \frac{-\partial(3xy)}{\partial y} = -3x$$

At point (1, 2)

$u = -3 \times 2 = -6$

$v = -3 \times 1 = -3$

i.e., x component $u = -6$

y component $v = -3$ Choice (D)

33. $D = 300$ mm

$= 0.3$ m

$L = 7$ m

$Q = 0.45\ m^3/s$

$f = 0.00498$

$$h_f = \frac{4fL}{d}\frac{v^2}{2g} = \frac{fLQ^2}{3D^5}$$

$$= \frac{0.00498 \times 700 \times (0.45)^2}{3 \times (0.3)^5}$$

$= 96.83$ m Choice (A)

34. Friction coefficient $f = \dfrac{16}{R_e}$

Friction factor $= 4f = \dfrac{64}{R_e}$ Choice (D)

35. Radius of the Mohr's circle

= Maximum shear stress

$$= \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= \sqrt{\left(\frac{900 - 300}{2}\right)^2 + 400^2}$$

$= 500$ MPa Choice (C)

36. Given $f(x, y, z) = x\ell nz - y^2 + 40$

$$\therefore \nabla f = \frac{\partial f}{\partial x}\bar{i} + \frac{\partial f}{\partial y}\bar{j} + \frac{\partial f}{\partial z}\bar{k} = \ell nz\,\bar{i} - 2y\,\bar{j} + \frac{x}{z}\bar{k}$$

$$\therefore \quad \nabla f_{at(-1, 2, 1)} = -4\,\bar{j} - \bar{k}$$

Let $\phi(x, y, z) = 4x^2y + z^3 - 4 = 0$

$\therefore$ Normal to the surface $\phi(x, y, z) = 0$ is

$$\nabla\phi = \frac{\partial\phi}{\partial x}\bar{i} + \frac{\partial\phi}{\partial y}\bar{j} + \frac{\partial\phi}{\partial x}\bar{k}$$

$$= 8xy\,\bar{i} + 4x^2\,\bar{j} + 3z^2\,\bar{k}$$

$\therefore$ Normal to $\phi(x, y, z) = 0$ at $(1, -1, 2)$ is

$$\nabla\phi_{at(1, -1, 2)} = -8\,\bar{i} + 4\,\bar{j} + 12\,\bar{k}$$

$$\therefore \ \hat{N} = \frac{\nabla\phi}{|\nabla\phi|} = \frac{-8\bar{i} + 4\bar{j} + 12\bar{k}}{\sqrt{(-8)^2 + 4^2 + 12^2}}$$

$$= \frac{4(-2\bar{i} + 4\,\bar{j} + 3\bar{k})}{4\sqrt{4 + 1 + 9}}$$

$$\hat{N} = \frac{-2}{\sqrt{14}}\,\bar{i} + \frac{1}{\sqrt{14}}\,\bar{j} + \frac{3}{\sqrt{14}}\bar{k}$$

$\therefore$ The directional derivative of $f(x, y, z)$ in the direction of the normal to the surface $\phi(x, y, z) = 0$ is $\nabla f.\ \hat{N}$

$$= (-4\,\bar{j} - \bar{k}).\left(\frac{-2}{\sqrt{14}}i + \frac{1}{\sqrt{14}}\bar{j} + \frac{3}{\sqrt{14}}\bar{k}\right)$$

$$= \frac{-4}{\sqrt{14}} - \frac{3}{\sqrt{14}} = -\sqrt{\frac{7}{2}}$$ Choice (C)

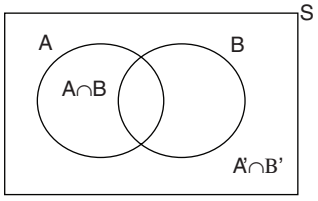
37. Given $P(B) = \dfrac{3}{5}$ and $P(A' \cap B') = \dfrac{1}{6}$

$$P\left(\frac{A}{B'}\right) = \frac{P(A \cap B')}{P(B')}$$

$$= \frac{P(A \cup B) - P(B)}{P(B')}$$

$$= \frac{1 - P(A' \cap B') - P(B)}{1 - P(B)}$$

$$= \frac{1 - \frac{1}{6} - \frac{3}{5}}{1 - \frac{3}{5}} = \frac{\frac{7}{30}}{\frac{2}{5}} = \frac{7}{12}$$



Choice (A)

38. (I) Given $f(x) = \begin{cases} 3x - [x]; & if\ x < 2 \\ 5 \quad\quad ; & if\ x = 2 \\ x + 3 \ ; & if\ x > 2 \end{cases}$

Left Limit $= \underset{x \to 2-}{Lt}\ f(x) = \underset{x \to 2-}{Lt}\ (3x - [x]) = 6 - 1 = 5$

Right Limit $= \underset{x \to 2+}{Lt}\ f(x) = \underset{x \to 2+}{Lt}\ (x + 3) = 2 + 3 = 5$ and

$f(2) = 5$

$$\therefore \quad \underset{x \to 2-}{Lt}\ f(x) = \underset{x \to 2+}{Lt}\ f(x) = f(2)$$

Hence $f(x)$ is continuous at $x = 2$

$\therefore$ (I) is true $\rightarrow$ (1)

(II) Given $g(x) = \begin{cases} \dfrac{x^2+2x-8}{x^2+3x-10}; & if\ x \neq 2 \\ \dfrac{5}{7} \quad\quad ; & if\ x = 2 \end{cases}$

$$\underset{\rightarrow}{Lt}\ g(x) = \underset{\rightarrow}{Lt}\ \frac{x^2+2x-8}{x^2+3x-10}$$

$$= \underset{x\to 2}{Lt}\ \frac{(x+4)(x-2)}{(x+5)(x-2)}$$

$$= \underset{x\to 2}{Lt}\ \frac{x+4}{x+5} = \frac{6}{7}$$

And $g(2) = \frac{6}{7}$

$\therefore$ $\underset{x\to 2}{Lt}\ g(x) \neq g(2)$

Hence $g(x)$ is not continuous at $x = 2$

$\therefore$ (II) is not true $\rightarrow$ (2).

Choice (A)

39. Given $-2 - 5i$ is an eigenvalue of a 3×3 real matrix A.

$\therefore$ $-2 + 5i$ is also an eigenvalue of A.

Let λ be the third eigenvalue of A

Given the trace of $A = -1$

i.e., $(-2 - 5i) + (-2 + 5i) + \lambda = -1$

$\Rightarrow$ $-4 + \lambda = -1 \Rightarrow \lambda = 3$

$\therefore$ The determinant of A = The product of the eigenvalues of A.

$= ((-2 - 5i)(-2 + 5i)\ 3$

$= 87$

Choice (C)

40. Given initial value problem is $\frac{d^2x}{dt^2} + 5\frac{dx}{dt} - 14x = 0$ $\rightarrow$ (1)

where $x(0) = 1$ and $\left(\frac{dx}{dt}\right)_{at\ t=0} = 2$ $\rightarrow$ (2)

Applying Laplace transform on both sides of (1),

we have $L\left[\frac{d^2x}{dt^2}\right] + 5L\left[\frac{dx}{dt}\right]_{t=0} - 14L[x] = L[0]$

$\Rightarrow$ $s^2\bar{x} - sx(0) - x'(0) + 5(s\bar{x} - x(0)) - 14\bar{x} = 0$

where $\bar{x} = L[x]$

$\Rightarrow$ $(s^2 + 5s - 14)\bar{x} - s \times 1 - 2 - 5 \times 1 = 0$

$\Rightarrow$ $(s^2 + 5s - 14)\bar{x} = s + 7$

$\Rightarrow$ $\bar{x} = \frac{(s+7)}{(s+7)(s-2)}$

$\Rightarrow$ $\bar{x} = \frac{1}{s-2}$

$\therefore$ The Laplace transform of the solution is

$\bar{x} = \frac{1}{s-2}$

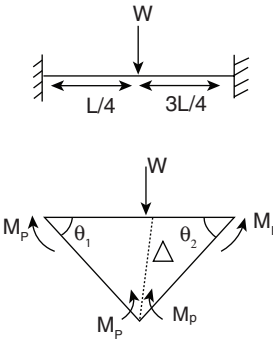
Choice (A)

42. Rivet value = Minimum of {5000, 8000, 6000} kg = 5000 kg.

Number of rivets = $\frac{84 \times 1000}{5000} = 16.8 \cong 17$ No.

Choice (D)

43.



$W.\Delta = 2\ M_p\theta_1 + 2M_p\theta_2$

$\theta_1 = \frac{\Delta}{\frac{L}{4}}$ and $\theta_2 = \frac{\Delta}{\frac{3L}{4}}$

$\Delta = \theta_1 . \frac{L}{4} = \theta_2 . \frac{3L}{4}$

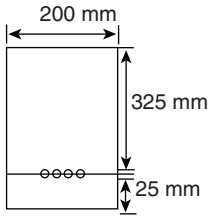
$\therefore$ $\theta_1 = 3\ \theta_2$

$W\Delta = 2M_p(3\ \theta_2 + \theta_2)$

$W . \frac{3L}{4} . \theta_2 = 2M_p . 4\ \theta_2$

$\therefore$ $W_c = \frac{32\ M_p}{3L}$. Choice (C)

44.



$b = 200$ mm and $d = 325$ mm

$Ast = 5 \times \frac{\pi}{4} \times 16^2 = 1005.3\ mm^2$

Depth of neutral Axis,

$$z_u = \frac{0.87 f_y\ Ast}{0.36\ fck.b} = \frac{0.87 \times 415 \times 1005.3}{0.36 \times 30 \times 200}$$

$= 167.988$ mm

$x_u, \max = 0.48\ d = 0.48 \times 325 = 156$ mm

$x_u > x_u$ max $\Rightarrow$ over reinforced section

So; $M_{u,\lim} = 0.36\ fck\ b\ x_{u,\max}(d - 0.42\ x_{u,\max})$

$= 0.36 \times 30 \times 200 \times 156(325 - 0.42(156))$

$= 87.43 \times 10^6$ N-mm $= 87.43$ kN-m. Choice (B)

45. Total hardness $= \left(Mg^{+2} \times \frac{50}{12.2}\right) + \left(Ca^{+2} \times \frac{50}{20}\right)$

$= \left(10 \times \frac{50}{12.2}\right) + \left(55 \times \frac{50}{20}\right)$

$= 179$ mg/l Choice (C)

46. Solid waste generated per day $= (2 \times 10^5) \times 2.5$ kg/day

$= 5,00,000$ kg/day

Total solid waste generated in 20 years $= 5 \times 10^5 \times 20 \times 365 = 365 \times 10^7$ kg

Compaction ratio $= 4 = \frac{\text{Volume before compaction}}{\text{Volume after compaction}}$

$\Rightarrow$ Volume before compaction,

$V = \frac{365 \times 10^7}{100} = 365 \times 10^5 \text{ m}^3$

$\frac{SW + \text{Cover}}{SW} = 1.5 \Rightarrow 1 + \frac{\text{Cover}}{SW} = 1.5$

Cover volume $= 0.5 \times 91.25 \times 10^5 = 45.625 \times 10^5$ m^3

$\therefore$ Total volume $= SW +$ Cover

$= (91.25 \times 10^5) + (45.625 \times 10^5)$

$= 13.7 \times 10^6$ m$^3 = 13.7$ million m^3 Choice (D)

47. Given that;

$\eta_1 = 80\%$ and $\eta_2 = 65\%$

Since, efficiency of up stream ESP is 80%; only 20% of particulates are not removed.

The remaining 20% particulates will face down stream ESP, which has an efficiency of 65%

So; particulates removed by down stream ESP = 65% of 20%

$= 20 \times \frac{65}{100} = 13\%$

Since they are connected in series, overall efficiency

$= 80\% + 13\% = 93\%$ Choice (B)

48. $\gamma_d = \frac{W_d}{V} = \frac{50}{50} = 1$ gm/cc

$G = \frac{\gamma_s}{\gamma_w} = \frac{w_s}{v_s \gamma_w}$

$\Rightarrow \quad v_s = \frac{w_s}{G\gamma_w} = \frac{50}{2.65 \times 1}$

$V_s = 18.868$ cm^3

$V = V_v + V_s$

$V_v = V - V_s = 50 - 18.868$

$V_v = 31.132$ ml Choice (A)

49. $SR = \left[\frac{\left(\frac{V_L - V_S}{V_S}\right)}{W_L - W_S}\right] \times 100 = \left[\frac{\left(\frac{7.5 - 4.5}{4.5}\right)}{40 - 5}\right] \times 100$

$SR = 1.904\%$

SR is nothing but $(G_m)_{\text{dry}}$

$\therefore \quad Ws = \left[\frac{1}{(G_m)_{dry}} - \frac{1}{G}\right] \times 100$

$5 = \left[\frac{1}{1.904} - \frac{1}{G}\right] \times 100$

$G = 2.10$ Choice (C)

50. $C_v = \frac{K}{m_v \gamma_w}$

$m_v = \frac{a_v}{1 + e_\circ} = \frac{\Delta e}{(1 + e_\circ)\Delta\sigma^1}$

$= \frac{(1.25 - 1.10)}{(1 + 1.25)(200)}$

$m_v = 3.33 \times 10^{-4}$ m^2/kN

$C_v = \frac{8 \times 10^{-8} \times 10^{-2} \text{ m/sec}}{3.33 \times 10^{-4} \text{ m}^2 \text{/KN} \times 9.81 \text{ kN/m}}$

$= 2.446 \times 10^{-5}$ m^2 /sec

$C_v = 7.72$ m^2/year Choice (B)

51. $T = \pi d^2 C_u \left(\frac{H}{2} + \frac{d}{6}\right)$

$C_u = \frac{T}{\pi d^2 \left(\frac{H}{2} + \frac{d}{6}\right)} = \frac{50 \times 100 \text{ N} - \text{cm}}{\pi \times (7.5)^2 \times \left(\frac{11.25}{2} + \frac{7.5}{6}\right)}$

$C_u = 4.11 \frac{\text{N}}{\text{cm}^2}$

$= 4.11 \times 10^4$ N/m^2

$C_u = 41.1$kN/m^2 Choice (B)

52. Seepage parallel to the slope,

$F = \frac{C^1 + \gamma^1 z \cos^2 i \tan\phi^1}{\gamma_{sat} Z \cos i \sin i}$

$= \frac{12 + (21 - 10) \times 5 \cos^2 10^0 \tan 30^0}{21 \times 5 \times \cos 10^\circ \times \sin 10^\circ} = 2.38.$

Choice (B)

53. $(k_p)_1 = \frac{1 + \sin\phi^1}{1 - \sin\phi^1} = \frac{1 + \sin 28}{1 - \sin 28} = 2.77$

$(k_p)_2 = \frac{1 + \sin 22^\circ}{1 - \sin 22^\circ} = 2.197$

At top

$Z = 0$;

$\sigma_v = \gamma_z = 0$

$(P_p)_A = (Kp_1)\sigma_v + 2C_1\sqrt{(Kp)_1}$

$= 0 + 2 \times 0 \times \sqrt{2.77} = 0$

At *B*

Just above:

$Kp_1 = 2.7$

$(\sigma_v) = (\gamma)_z = 18 \times 3 = 54 \text{ kN/m}^2$

$\left[(P_p)_B\right]_{at\ top} = 2.77 \times 54 + 2 \times 0 \times \sqrt{2.77}$

$(P_p)_B = 149.58 \text{ kN/m}^2$

Just below

$(Kp)_2 = 2.197 ; C_2 = 10 \text{ kN/m}^2$

$(\sigma_v) = (\gamma) \times z = 18 \times 3 = 54 \text{ kN/m}^2$

$\left[(P_p)_B\right]_{below} = (2.197) \times 54 + 2 \times 10 \times \sqrt{2.197}$

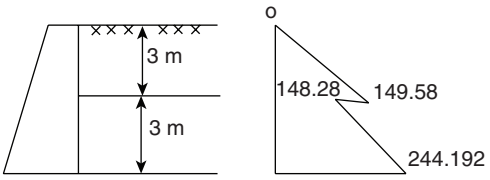
$= 148.28 \text{ kN/m}^2$

At C(i.e; at Bottom):

$(\sigma_v) = 18 \times 3 + (20 - 10) \times 3 = 84 \text{ kN/m}^2$

$\left[(P_p)_c\right] = (2.197) \times 84 + 2 \times 10\sqrt{2.197} + 3 \times 10$

$= 244.192$



Pressure diagram

Total Passive force

$= \frac{1}{2} \times 149.58 \times 3 + \left[\frac{148.28 + 244.192}{2}\right] \times 3$

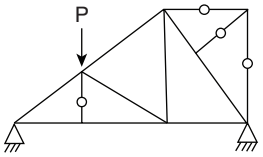
= 813.078 kN. Choice (A)

54.

Joint	Members	Relative stiffness, K	∑K	D.F = $\frac{K}{\Sigma K}$
E	EB	$\frac{3\,I}{4(4L)} = \frac{3\,I}{16L}$	$\frac{49I}{48L}$	$\frac{I \times 48L}{4L \times 49\,I} = \frac{12}{49}$
	EC	$\frac{I}{3L}$		
	ED	$\frac{I}{4\,L}$		
	EA	$\frac{3\,I}{4(3L)} = \frac{3\,I}{12\,L}$		

Choice (A)

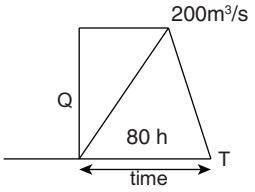
55. The Zero force members are marked below:



Choice (B)

56. $P = \frac{250}{2}\left[\frac{140}{200} + \frac{270}{300}\right] = 200 \text{ mm}$ Choice (D)

57.



Total runoff = Area of triangle

$= \frac{1}{2} \times 80 \times 3600 \times 200$

$= 28.8 \times 10^6 \text{ m}^3$

Area of catchment = 1440 cm²

∴ Effective rainfall

$= \frac{\text{Total runoff}}{\text{Area of Catchment}} = \frac{28.8 \times 10^6}{1440 \times 10^6} = 0.02 \text{ m}$

= 2 cm Choice (D)

58. $S = 2000$

Displacement of field = $L \sin\alpha$

∴ Displacement on the paper = $\frac{L \sin\alpha}{S}$

$0.25 = \frac{L \sin(2.5)}{2000} \Rightarrow L = \frac{0.25 \times 2000}{\sin 25} = 11462 \text{ mm}$

$= 11.462 \text{ m}$ Choice (A)

59. Difference between two consecutive points is

$\frac{1}{50} \times 20 = 0.4 \text{ m}$

Staff reading at A = 0.55 m staff reading at B should be 0.4 m lower than A (staff reading increases by 0.4 m)

i.e; = 0.55 + 0.4 = 0.95 m. Choice (A)

61. Design speed V = 80 kmph =22.22m/s

$\text{SSD} = vt + \frac{v^2}{2gf} = (22.22 \times 2.5) + \frac{(22.22)^2}{2 \times 9.81 \times 0.35}$

$= 127.45 \text{ m}$

Safe SSD = 2 × SSD = 2 × 127.5 = 255 m

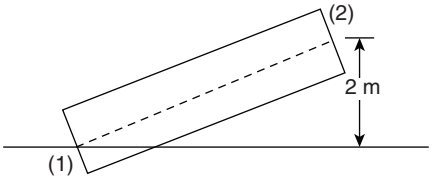
deviation angle N= 3 – (-5) = 8 %

length of summit curve

$L = \frac{NS^2}{4.4} = \frac{\left(\frac{8}{100}\right)(255)^2}{4.4} = 1182 \text{ m}$ Choice (B)

63. At Point E: $h_E = 100 - 30 = 70\%$
At Point D: $h_D = 100 - 40 = 60\%$. Choice (C)

64.



$D = 250$ mm $= 0.25$ m
$Z_2 - Z_1 = 2$ m
$V_1 = V_2 = 1.25$ m/s
$p_1 = 50$ k Pa
$p_2 = 20$ k Pa

$$A_1 = A_2 = \frac{\pi D^2}{4} = \frac{\pi \times (0.25)^2}{4} = 0.0491 \text{ m}^2$$

Rate of flow $= A_1 V_1$
$= 0.0491 \times 1.25$
$= 0.0614$ m^3/s

Total energy difference

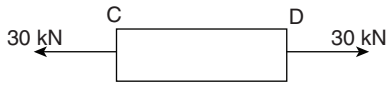
$$E_1 - E_2 = \frac{P_1 - P_2}{w} + \frac{V_1^2 - V_2^2}{2g} + (Z_1 - Z_2)$$

$$= \frac{(50-20)10^3}{9810} + 0 - 2$$

$= 1.0581$ m

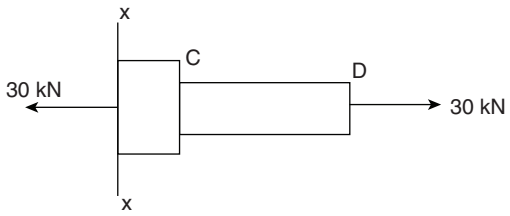
As $E_1 > E_2$, the flow is upwards Choice (A)

65. Portion CD



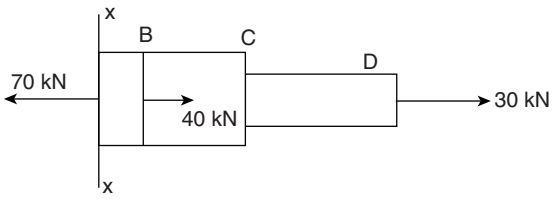
Force acting = 30 kN (Tensile).

Portion BC (consider section xx)



Force acting = 30 k N (Tensile).

Portion AB (consider section xx)



Force acting = 70 kN (Tensile)

Extension produced $= \sum \frac{PL}{AE}$

$$= \frac{30 \times 10^3 \times 500}{\frac{\pi}{4}(30)^2 \times 1.1 \times 10^5} + \frac{30 \times 10^3 \times 250}{\frac{\pi}{4}(40)^2 \times 2 \times 10^5} + \frac{70 \times 10^3 \times 250}{\frac{\pi}{4}(40)^2 \times 2 \times 10^5}$$

$$= \frac{4 \times 250}{\pi \times 10^2}\left[\frac{30 \times 2}{1.1 \times (30)^2} + \frac{30 \times 1}{2 \times (40)^2} + \frac{70 \times 1}{2 \times (40)^2}\right]$$

$= 0.2924$ mm Choice (B)