GATE Civil Engineering

Sample Paper – 3

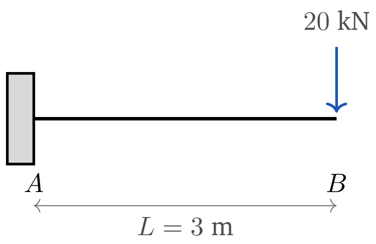
Duration: 128 Minutes **Maximum Marks: 72**

Instructions

- This paper contains **46 questions** covering the core **Civil Engineering** subject of the GATE paper conducted by the IITs and IISc (General Aptitude and Engineering Mathematics are provided as separate papers).
- **Q1–Q20 carry 1 mark each** and **Q21–Q46 carry 2 marks each**, for a total of **72 marks**.
- Each question carries **negative marking of one-third of its allotted marks**: a wrong 1-mark question costs **0.33** and a wrong 2-mark question costs **0.67**. Unattempted questions carry no penalty.
- Every question here is a single-correct **MCQ**. The real GATE paper also has Multiple Select (MSQ) and Numerical Answer Type (NAT) questions, and **those carry no negative marking**.
- Attempt this paper in one timed sitting of about **128 minutes**, the share this core subject earns at GATE's overall pace of 180 minutes for 65 questions. Take $g = 9.81$ m/s^2 and unit weight of water $\gamma_w = 9.81$ kN/m^3 unless stated otherwise.

Structural Engineering

Q1. A cantilever beam of length 3 m is fixed at A and carries a single point load of 20 kN at its free end B, as shown. The magnitude of the maximum bending moment in the beam (at the fixed support) is: **[1 mark]**



(A) 20 kN·m

(B) 60 kN·m

(C) 30 kN·m

(D) 40 kN·m

Q2. A steel rod of length 2 m and cross-sectional area 500 mm^2 carries an axial tensile load of 50 kN. Taking the modulus of elasticity $E = 200$ GPa, the axial elongation of the rod is: **[1 mark]**

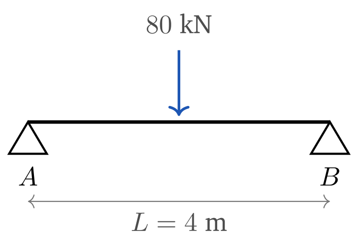
(A) 1.0 mm

(B) 0.5 mm

(C) 2.0 mm

(D) 0.25 mm

Q3. A simply supported beam AB of span 4 m carries a single concentrated load of 80 kN at its midspan, as shown. The maximum shear force in the beam is: **[1 mark]**



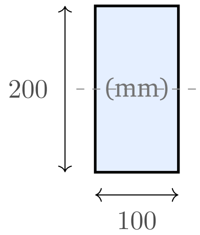
(A) 80 kN

(B) 20 kN

(C) 60 kN

(D) 40 kN

Q4. A solid rectangular cross-section has a width $b = 100$ mm and a depth $d = 200$ mm, as shown. Its second moment of area (moment of inertia) about the centroidal axis parallel to the width is: **[1 mark]**



(A) 1.333×10^8 mm^4

(B) 3.333×10^7 mm^4

(C) 5.0×10^7 mm^4

(D) 6.667×10^7 mm^4

Q5. A hinged–hinged (pin-ended) column has a length of 3 m and a least radius of gyration of 25 mm. The slenderness ratio of the column is: **[1 mark]**

(A) 75

(B) 100

(C) 120

(D) 150

Q6. For an isotropic elastic material the modulus of rigidity is $G = 80$ GPa and Poisson's ratio is $\mu = 0.25$. Using $E = 2G(1 + \mu)$, the modulus of elasticity E is: **[1 mark]**

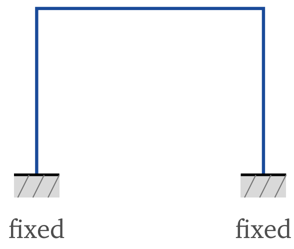
(A) 200 GPa

(B) 160 GPa

(C) 100 GPa

(D) 240 GPa

Q7. The single-bay, single-storey portal frame shown below is fixed at both column bases. Neglecting nothing (plane frame, loads in its plane), the static (external) degree of indeterminacy of the frame is: **[1 mark]**



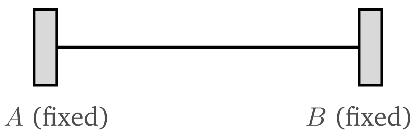
(A) 1

(B) 3

(C) 6

(D) 0

Q8. A prismatic beam is fully fixed (built in against rotation and translation) at both ends, as shown. Neglecting axial deformation, the kinematic indeterminacy (number of unknown independent joint displacements) of the beam is: **[1 mark]**



(A) 2

(B) 1

(C) 0

(D) 3

Q9. In the plastic analysis of beams, the ratio of the plastic moment capacity to the yield moment (that is, the fully-plastic moment divided by the moment at first yield) is called the shape factor. For a solid *rectangular* cross-section the shape factor is: **[1 mark]**

(A) 1.0

(B) 2.0

(C) 1.7

(D) 1.5

Q10. In the moment-distribution method, a moment is applied at one (near) end of a prismatic member whose far end is fixed. The carry-over factor, that is the ratio of the moment induced at the far end to the moment applied at the near end, is: **[1 mark]**

(A) 1.0

(B) 0.5

(C) 0.25

(D) 0.75

Q11. In the working-stress method of RCC design, the modular ratio is taken as $m = \dfrac{280}{3\,\sigma_{cbc}}$, where σ_{cbc} is the permissible compressive stress in bending of concrete. For M20 concrete, $\sigma_{cbc} = 7$ N/mm^2. The modular ratio is: **[1 mark]**

(A) 9.33

(B) 18.67

(C) 10.0

(D) 13.33

Q12. In the limit state method of IS 456:2000, the design load for the basic combination of dead load (DL) and imposed (live) load (LL) is taken as $1.5\,(\text{DL} + \text{LL})$. The partial safety factor applied to the dead load in this combination is: **[1 mark]**

(A) 1.15

(B) 1.5

(C) 1.0

(D) 1.2

Q13. As per IS 456:2000, the minimum eccentricity for the design of a short column is $e_{\min} = \dfrac{L}{500} + \dfrac{D}{30}$, but not less than 20 mm. For an unsupported length $L = 3000$ mm and a lateral dimension $D = 300$ mm, the minimum eccentricity to be used is: **[1 mark]**

(A) 20 mm

(B) 16 mm

(C) 6 mm

(D) 10 mm

Q14. In a CPM network an activity has an earliest start time of 5 days and a latest start time of 8 days. The total float of the activity is: **[1 mark]**

(A) 5 days

(B) 8 days

(C) 3 days

(D) 13 days

Geotechnical Engineering

Q15. A soil sample has a bulk (moist) unit weight of 20 kN/m^3 at a water content of 25%. The dry unit weight of the soil is: **[1 mark]**

(A) 25.0 kN/m^3

(B) 15.0 kN/m^3

(C) 12.5 kN/m^3

(D) 16.0 kN/m^3

Q16. A cohesionless soil has a maximum void ratio of 0.90, a minimum void ratio of 0.40 and a natural (in-situ) void ratio of 0.65. The relative density (density index) of the soil is: **[1 mark]**

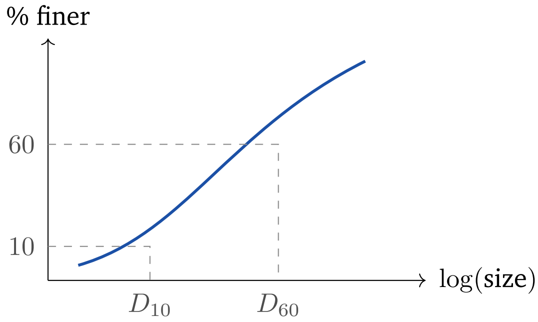
(A) 25%

(B) 50%

(C) 40%

(D) 65%

Q17. The particle-size distribution curve of a soil, drawn on a semi-log plot, is shown. From it the effective size is $D_{10} = 0.15$ mm and $D_{60} = 0.60$ mm. The uniformity coefficient $C_u = D_{60}/D_{10}$ of the soil is: **[1 mark]**



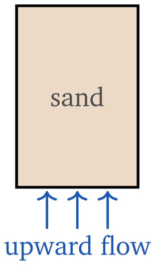
(A) 4.0

(B) 2.0

(C) 0.25

(D) 6.0

Q18. Water flows vertically upward through a sand sample, as shown. The specific gravity of the solids is $G = 2.65$ and the void ratio is $e = 0.65$. The critical hydraulic gradient $i_c = \dfrac{G-1}{1+e}$ at which the sand just loses its strength (quick condition) is: **[1 mark]**



(A) 1.65

(B) 0.65

(C) 2.65

(D) 1.0

Q19. In Terzaghi's one-dimensional consolidation theory, the dimensionless time factor T_v corresponding to an average degree of consolidation of 50% is nearest to: **[1 mark]**

(A) 0.848

(B) 0.500

(C) 0.197

(D) 1.000

Q20. A clay has a liquid limit of 50% and a plastic limit of 25%. Its natural water content is 30%. The consistency index $I_c = \dfrac{\text{LL} - w}{\text{PI}}$ of the clay is: [1 mark]

(A) 0.4

(B) 1.0

(C) 0.2

(D) 0.8

Geotechnical Engineering (continued)

Q21. A normally consolidated clay layer 4 m thick has an initial void ratio of 0.80 and a compression index of 0.30. Under a foundation load the effective vertical stress at the middle of the layer increases from 100 kPa to 200 kPa. Using $S_c = \dfrac{C_c H}{1+e_0}\log_{10}\dfrac{\sigma'_f}{\sigma'_0}$, the primary consolidation settlement is nearest to: [2 marks]

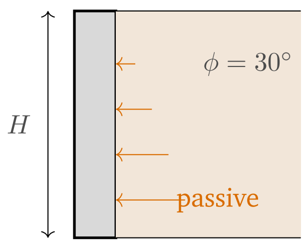
(A) 200 mm

(B) 100 mm

(C) 301 mm

(D) 67 mm

Q22. A smooth vertical retaining wall supports a dry cohesionless backfill of friction angle $\phi = 30^\circ$ with a horizontal top surface, as shown. Using Rankine's theory, the coefficient of *passive* earth pressure $K_p = \dfrac{1+\sin\phi}{1-\sin\phi}$ for the backfill is: [2 marks]



(A) 0.333

(B) 1.0

(C) 2.0

(D) 3.0

Q23. A strip footing of width 2 m is founded at a depth of 1.5 m in a dry cohesionless sand of unit weight 18 kN/m^3 (effective cohesion $c' = 0$). For the sand, the Terzaghi bearing-capacity factors are $N_q = 18$ and $N_\gamma = 15$. Using $q_u = c'N_c + \gamma D_f N_q + 0.5\,\gamma B N_\gamma$, the ultimate bearing capacity is: **[2 marks]**

(A) 756 kPa

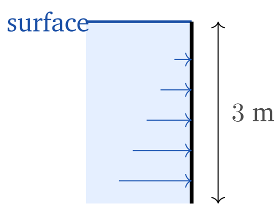
(B) 486 kPa

(C) 270 kPa

(D) 400 kPa

Water Resources Engineering

Q24. A vertical rectangular gate is 2 m wide and 3 m deep, with its top edge coinciding with the free water surface on one side, as shown. Measured from the free surface, the depth of the centre of pressure on the gate is: **[2 marks]**



gate (2 m wide)

(A) 1.5 m

(B) 3.0 m

(C) 1.0 m

(D) 2.0 m

Q25. Water (density 1000 kg/m^3, dynamic viscosity $\mu = 1.0 \times 10^{-3}$ Pa$\cdot$s) flows through a pipe of diameter 0.10 m at a mean velocity of 2 m/s. The Reynolds number of the flow is: **[2 marks]**

(A) 2000

(B) 20000

(C) 200000

(D) 2×10^6

Q26. Water flows uniformly in a wide open channel. Using Manning's equation $V = \frac{1}{n} R^{2/3} S^{1/2}$ with Manning's roughness $n = 0.015$, hydraulic radius $R = 1.0$ m and bed slope $S = 0.0001$, the mean velocity of flow is nearest to: **[2 marks]**

(A) 0.15 m/s

(B) 0.33 m/s

(C) 0.67 m/s

(D) 1.00 m/s

Q27. In a rectangular channel the critical depth of flow for a given discharge is 1.2 m. For critical flow the minimum specific energy equals 1.5 times the critical depth. The minimum specific energy of the channel is: **[2 marks]**

(A) 1.8 m

(B) 1.2 m

(C) 2.4 m

(D) 0.8 m

Q28. Water flows in a rectangular channel at a mean velocity of 6 m/s and a depth of 1 m. The Froude number of the flow (take $g = 9.81$ m/s^2) is nearest to: **[2 marks]**

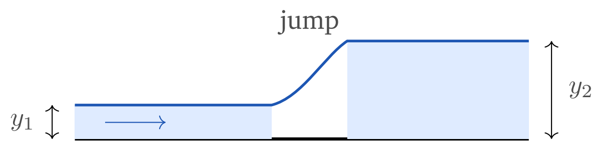
(A) 0.96

(B) 1.92

(C) 3.83

(D) 0.61

Q29. A hydraulic jump forms in a horizontal rectangular channel where the approach (pre-jump) Froude number is $F_1 = 3.0$. Using the sequent-depth relation $\frac{y_2}{y_1} = \frac{1}{2}\left(\sqrt{1 + 8F_1^2} - 1\right)$, the ratio of the conjugate depths y_2/y_1 is nearest to: **[2 marks]**



(A) 8.54

(B) 3.77

(C) 7.54

(D) 4.00

Q30. A pump lifts water at a discharge of 0.5 m^3/s against a total (net) head of 20 m. Assuming 100% efficiency and taking $\rho_w g = 9.81$ kN/m^3, the power delivered to the water by the pump is nearest to: **[2 marks]**

(A) 9.81 kW

(B) 49.05 kW

(C) 98.1 kW

(D) 196.2 kW

Q31. A storm of duration 3 hours delivers rainfall at a uniform intensity of 2 cm/hr over a catchment. The resulting direct surface runoff is 3 cm. Assuming a uniform loss (infiltration) rate, the ϕ-index of the catchment is: **[2 marks]**

(A) 3.0 cm/hr

(B) 2.0 cm/hr

(C) 1.0 cm/hr

(D) 0.5 cm/hr

Q32. A confined aquifer has a coefficient of permeability of 25 m/day and a saturated thickness of 20 m. The transmissivity $T = k\,b$ of the aquifer is: **[2 marks]**

(A) 1.25 m^2/day

(B) 500 m^2/day

(C) 45 m^2/day

(D) 5 m^2/day

Q33. The net depth of water to be applied to a crop at each irrigation is 6 cm, and the peak consumptive-use rate of the crop is 3 mm/day. The maximum permissible frequency of irrigation (interval between successive waterings) is: **[2 marks]**

(A) 2 days

(B) 18 days

(C) 20 days

(D) 30 days

Q34. A hydraulic structure is designed for a flood having a return period of 50 years. The probability that a flood of this magnitude (or greater) does *not* occur in the next 2 years is nearest to: **[2 marks]**

(A) 0.04

(B) 0.96

(C) 0.98

(D) 0.02

Environmental Engineering

Q35. In the disinfection of water, a chlorine dose of 5.0 mg/L is applied and the free chlorine residual measured after the contact period is 0.5 mg/L. The chlorine demand of the water is: **[2 marks]**

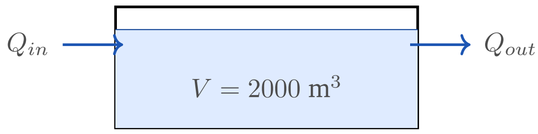
(A) 4.5 mg/L

(B) 5.5 mg/L

(C) 5.0 mg/L

(D) 0.5 mg/L

Q36. A sedimentation tank of volume 2000 m^3 treats a steady flow of 4000 m^3/day. The detention (retention) time of the tank is: **[2 marks]**



(A) 0.5 hr

(B) 2 hr

(C) 12 hr

(D) 24 hr

Q37. A rapid sand filter is to treat a design flow of 5 million litres per day (MLD). The rate of filtration adopted is 5000 litres per square metre per hour. The plan (surface) area of the filter required is nearest to: **[2 marks]**

(A) 20.8 m^2

(B) 41.7 m^2

(C) 83.3 m^2

(D) 100 m^2

Q38. Two independent machines in a workshop each produce a sound-pressure level of 60 dB at a point. When both operate together, the combined sound level at that point (adding on the logarithmic decibel scale, where doubling the acoustic power adds 3 dB) is: **[2 marks]**

(A) 120 dB

(B) 63 dB

(C) 66 dB

(D) 60 dB

Q39. The loose density of municipal solid waste in a storage bin is 100 kg/m^3. After compaction in a collection vehicle its density becomes 500 kg/m^3. The percentage reduction in the volume of the waste due to compaction is: **[2 marks]**

(A) 80%

(B) 5%

(C) 20%

(D) 500%

Transportation & Geomatics Engineering

Q40. A vehicle moves on a level highway at a design speed of 72 km/h. The driver's total perception–reaction time is 2.5 s. The lag (reaction) distance travelled by the vehicle during this reaction time, that is the distance covered before the brakes are applied, is: **[2 marks]**

(A) 25 m

(B) 50 m

(C) 100 m

(D) 20 m

Q41. On a highway a rising gradient of $+3\%$ meets a falling gradient of -2% at a summit, forming the vertical curve shown. The deviation angle N (algebraic difference of the two grades, expressed as a fraction) at the summit is: **[2 marks]**

(A) 0.01

(B) 0.03

(C) 0.02

(D) 0.05

Q42. A traffic stream follows Greenshields' linear speed–density model with a free-flow speed of 60 km/h and a jam density of 120 veh/km. The speed of the stream at which the flow is a maximum (that is, the optimum speed, equal to half the free-flow speed) is: **[2 marks]**

(A) 60 km/h

(B) 120 km/h

(C) 15 km/h

(D) 30 km/h

Q43. In a compass survey the fore bearing (whole-circle bearing) of a line AB is measured as $120°$. The back bearing of the line (the bearing of BA) is: **[2 marks]**

(A) $300°$

(B) $60°$

(C) $240°$

(D) $120°$

Q44. A chain survey is carried out with a 30 m chain that, due to wear, is actually 30.1 m long (that is, 0.1 m too long). The length of a line as measured with this chain is 900 m. The true (corrected) length of the line is: **[2 marks]**

(A) 897 m

(B) 900 m

(C) 903 m

(D) 906 m

Q45. A survey line AB is 100 m long and its whole-circle bearing is $30°$. The latitude of the line (its projection on the north–south axis, $L\cos\theta$) is nearest to: **[2 marks]**

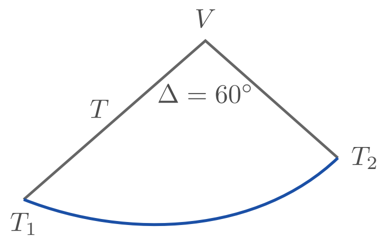
(A) 86.6 m

(B) 50.0 m

(C) 100 m

(D) 43.3 m

Q46. A simple circular highway curve of radius 200 m has a deflection (intersection) angle of $60°$, as shown. The tangent length $T = R\tan(\Delta/2)$ of the curve is nearest to: **[2 marks]**



(A) 115.47 m

(B) 100 m

(C) 200 m

(D) 57.74 m

Detailed Solutions

Q1.

Solution

Concept – bending moment in a cantilever under an end load: For a cantilever the bending moment is largest at the fixed support and equals the load multiplied by its distance from that support.

Step 1 – list the data: Length $L = 3$ m, end load $W = 20$ kN.

Step 2 – write the moment at the fixed support: $M_{\text{max}} = W \times L$

Step 3 – substitute the values: $M_{\text{max}} = 20 \times 3$

Step 4 – evaluate: $M_{\text{max}} = 60$ kN·m

Final Answer: $M_{\text{max}} = 60$ kN·m $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept – axial elongation of a bar: $\delta = \dfrac{P\,L}{A\,E}$, where P is the axial load, L the length, A the area and E the modulus.

Step 1 – convert everything to consistent units (N and mm): $P = 50 \text{ kN} = 50000 \text{ N}$

$L = 2 \text{ m} = 2000 \text{ mm}$

$A = 500 \text{ mm}^2$

$E = 200 \text{ GPa} = 200000 \text{ N/mm}^2$

Step 2 – form the numerator $P\,L$**:** $P\,L = 50000 \times 2000$

$P\,L = 1.0 \times 10^8 \text{ N} \cdot \text{mm}$

Step 3 – form the denominator $A\,E$**:** $A\,E = 500 \times 200000$

$A\,E = 1.0 \times 10^8 \text{ N}$

Step 4 – divide: $\delta = \dfrac{1.0 \times 10^8}{1.0 \times 10^8}$

$\delta = 1.0 \text{ mm}$

Final Answer: $\delta = 1.0$ mm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept – shear force under a central point load: For a simply supported beam with a load W at midspan, each reaction is $W/2$, and the maximum shear force equals that reaction.

Step 1 – find the support reactions: By symmetry $R_A = R_B = \dfrac{W}{2}$.

Step 2 – substitute the load: $R_A = \dfrac{80}{2}$

$R_A = 40$ kN

Step 3 – identify the maximum shear force: The shear force is constant at 40 kN from either support up to the load point, so $V_{\max} = 40$ kN.

Final Answer: $V_{\max} = 40 \text{ kN} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q3

Q4.

Solution

Concept – moment of inertia of a rectangle: About the centroidal axis parallel to the width, $I = \dfrac{b\,d^3}{12}$.

Step 1 – list the dimensions: $b = 100$ mm, $d = 200$ mm.

Step 2 – cube the depth: $d^3 = 200^3$

$d^3 = 8.0 \times 10^6 \text{ mm}^3$

Step 3 – multiply by the width: $b\,d^3 = 100 \times 8.0 \times 10^6$

$b\,d^3 = 8.0 \times 10^8 \text{ mm}^4$

Step 4 – divide by 12**:** $I = \dfrac{8.0 \times 10^8}{12}$

$I = 6.667 \times 10^7 \text{ mm}^4$

Final Answer: $I = 6.667 \times 10^7 \text{ mm}^4 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept – slenderness ratio: $\lambda = \dfrac{L_e}{r_{\min}}$, where L_e is the effective length and $r_{\min}$ the least radius of gyration.

Step 1 – find the effective length: For a pin-ended (hinged–hinged) column the effective length equals the actual length.

$L_e = 1.0 \times L = 3 \text{ m} = 3000 \text{ mm}$

Step 2 – list the radius of gyration: $r_{\min} = 25$ mm.

Step 3 – form the ratio: $\lambda = \dfrac{3000}{25}$

Step 4 – evaluate: $\lambda = 120$

Final Answer: $\lambda = 120 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept – elastic constants relation: $E = 2G(1 + \mu)$ links the modulus of elasticity, the modulus of rigidity and Poisson's ratio.

Step 1 – list the data: $G = 80$ GPa, $\mu = 0.25$.

Step 2 – form the bracket: $1 + \mu = 1 + 0.25 = 1.25$

Step 3 – substitute: $E = 2 \times 80 \times 1.25$

Step 4 – multiply step by step: $2 \times 80 = 160$

$E = 160 \times 1.25$

$E = 200$ GPa

Final Answer: $E = 200 \text{ GPa} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept – static indeterminacy of a plane frame from reactions: For a frame with no internal closed loop (an open, tree-like frame), the degree of static indeterminacy equals the number of support reactions minus the three available equations of equilibrium.

Step 1 – count the reaction components: Each fixed support provides 3 reactions (horizontal, vertical and moment). Two fixed bases give $r = 3 + 3 = 6$.

Step 2 – note the internal condition: A single-bay single-storey portal frame has no closed ring of members going all the way around, so the internal indeterminacy is 0.

Step 3 – apply the external indeterminacy formula: $D_s = r - 3$

$D_s = 6 - 3$

$D_s = 3$

Final Answer: $D_s = 3 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept – kinematic indeterminacy counts the unknown joint displacements: It is the number of independent rotations and translations the joints can undergo.

Step 1 – examine the two joints: Both ends A and B are fully fixed, so neither can rotate nor translate.

Step 2 – count the free displacements: Rotation at A: prevented. Rotation at B: prevented. Vertical/horizontal translation: prevented at both ends, and axial deformation is neglected.

Step 3 – total the unknowns: Number of unknown joint displacements $= 0$.

Final Answer: kinematic indeterminacy $= 0 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept – shape factor of a section: The shape factor $S = \dfrac{M_p}{M_y} = \dfrac{Z_p}{Z_e}$, the ratio of the plastic section modulus to the elastic section modulus.

Step 1 – write the elastic modulus of a rectangle: $Z_e = \dfrac{b\,d^2}{6}$

Step 2 – write the plastic modulus of a rectangle: $Z_p = \dfrac{b\,d^2}{4}$

Step 3 – form the ratio: $S = \dfrac{Z_p}{Z_e} = \dfrac{b\,d^2/4}{b\,d^2/6}$

Step 4 – simplify: $S = \dfrac{6}{4}$

$S = 1.5$

Why the other options are wrong:

- C, 1.7: is the shape factor of a solid **circular** section, not a rectangle.
- B, 2.0: is the shape factor of a **diamond** (square rotated $45°$).
- A, 1.0: would mean no reserve strength beyond first yield, which is not true for a rectangle.

Final Answer: $S = 1.5 \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q9**

Q10.

Solution

Concept – carry-over factor in moment distribution: For a prismatic member with the far end fixed, half of the moment applied at the near end is carried over to the far end.

Step 1 – recall the standard result: Carry-over factor $= \dfrac{\text{moment induced at far end}}{\text{moment applied at near end}}$.

Step 2 – state its value for a prismatic member (far end fixed): Carry-over factor $= 0.5$.

Why the other options are wrong:

- A, 1.0: would mean the full moment is transmitted, which does not hold for a prismatic member.
- C, 0.25 and D, 0.75: are not the standard carry-over value for a prismatic member with a fixed far end.

Final Answer: carry-over factor $= 0.5 \Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q10**

Q11.

Solution

Concept – modular ratio in working-stress design: $m = \dfrac{280}{3\,\sigma_{cbc}}$, where σ_{cbc} is the permissible bending compressive stress of the concrete.

Step 1 – list the data: For M20 concrete, $\sigma_{cbc} = 7$ N/mm^2.

Step 2 – form the denominator: $3 \times \sigma_{cbc} = 3 \times 7 = 21$

Step 3 – divide: $m = \dfrac{280}{21}$

Step 4 – evaluate: $m = 13.33$

Final Answer: $m = 13.33 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

Q12.

Solution

Concept – partial safety factor for loads (limit state): In the basic gravity combination IS 456 uses $1.5\,(\text{DL} + \text{LL})$, so the same factor 1.5 multiplies the dead load.

Step 1 – read the load combination: Design load $= 1.5\,(\text{DL} + \text{LL})$.

Step 2 – extract the dead-load factor: The factor on the dead load is 1.5.

Why the other options are wrong:

- A, 1.15: is the partial safety factor for reinforcing **steel** (a material factor), not a load factor.
- C, 1.0: is the factor used for dead load in some *serviceability* combinations, not in this strength combination.
- D, 1.2: is the factor used when DL, LL and **wind/earthquake** act together, not for the basic DL+LL case.

Final Answer: dead-load factor $= 1.5 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q12

Q13.

Solution

Concept – minimum eccentricity with a lower bound: $e_{\min} = \frac{L}{500} + \frac{D}{30}$, but IS 456 requires it be taken not less than 20 mm.

Step 1 – evaluate the first term: $\frac{L}{500} = \frac{3000}{500} = 6$ mm

Step 2 – evaluate the second term: $\frac{D}{30} = \frac{300}{30} = 10$ mm

Step 3 – add the two terms: $e_{\min,\text{calc}} = 6 + 10 = 16$ mm

Step 4 – apply the lower bound: The computed value 16 mm is less than the code minimum of 20 mm, so the governing value is 20 mm.

Final Answer: $e_{\min} = 20$ mm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept – total float in a CPM network: Total float = LST − EST (equivalently the latest finish minus the earliest finish).

Step 1 – list the data: Earliest start time EST = 5 days, latest start time LST = 8 days.

Step 2 – subtract: Total float $= 8 - 5$

Step 3 – evaluate: Total float $= 3$ days

Final Answer: total float $= 3$ days $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept – dry unit weight from bulk unit weight: $\gamma_d = \frac{\gamma}{1+w}$, where γ is the bulk unit weight and w the water content (as a fraction).

Step 1 – express the water content as a fraction: $w = 25\% = 0.25$

Step 2 – form the denominator: $1 + w = 1 + 0.25 = 1.25$

Step 3 – divide: $\gamma_d = \frac{20}{1.25}$

Step 4 – evaluate: $\gamma_d = 16\ \text{kN/m}^3$

Final Answer: $\gamma_d = 16\ \text{kN/m}^3 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept – relative density (density index): $D_r = \dfrac{e_{\max} - e}{e_{\max} - e_{\min}}$, comparing the natural void ratio with its loosest and densest limits.

Step 1 – list the data: $e_{\max} = 0.90$, $e_{\min} = 0.40$, $e = 0.65$.

Step 2 – form the numerator: $e_{\max} - e = 0.90 - 0.65 = 0.25$

Step 3 – form the denominator: $e_{\max} - e_{\min} = 0.90 - 0.40 = 0.50$

Step 4 – divide: $D_r = \dfrac{0.25}{0.50} = 0.50$

$D_r = 50\%$

Final Answer: $D_r = 50\% \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept – uniformity coefficient: $C_u = \dfrac{D_{60}}{D_{10}}$, the ratio of the 60%-finer size to the effective (10%-finer) size.

Step 1 – read the sizes from the curve: $D_{60} = 0.60$ mm, $D_{10} = 0.15$ mm.

Step 2 – form the ratio: $C_u = \dfrac{0.60}{0.15}$

Step 3 – evaluate: $C_u = 4.0$

Step 4 – interpret: A value of 4 (greater than 1) indicates a reasonably well-graded soil in this respect.

Final Answer: $C_u = 4.0 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept – critical (quick-sand) hydraulic gradient: $i_c = \dfrac{G-1}{1+e}$, the gradient at which upward seepage force just balances the submerged weight of the soil.

Step 1 – list the data: $G = 2.65$, $e = 0.65$.

Step 2 – form the numerator: $G - 1 = 2.65 - 1 = 1.65$

Step 3 – form the denominator: $1 + e = 1 + 0.65 = 1.65$

Step 4 – divide: $i_c = \dfrac{1.65}{1.65}$

$i_c = 1.0$

Final Answer: $i_c = 1.0 \Rightarrow \boxed{\text{D}}$

$\boxed{\text{Answer: (D)}}$ Go Back to Q18

Q19.

Solution

Concept – Terzaghi consolidation time factor: T_v is a fixed number for each average degree of consolidation U; for $U \leq 60\%$ it follows $T_v = \dfrac{\pi}{4}U^2$.

Step 1 – put $U = 50\% = 0.5$: $T_v = \dfrac{\pi}{4}(0.5)^2$

Step 2 – square the degree of consolidation: $(0.5)^2 = 0.25$

Step 3 – multiply by $\pi/4$: $T_v = 0.7854 \times 0.25$

$T_v = 0.196$

Step 4 – round to the standard tabulated value: $T_v \approx 0.197$

Final Answer: $T_v \approx 0.197 \Rightarrow \boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q19

Q20.

Solution

Concept – consistency index: $I_c = \dfrac{\text{LL} - w}{\text{PI}}$, where the plasticity index $\text{PI} = \text{LL} - \text{PL}$.

Step 1 – compute the plasticity index: $\text{PI} = \text{LL} - \text{PL} = 50 - 25 = 25$

Step 2 – form the numerator: $\text{LL} - w = 50 - 30 = 20$

Step 3 – divide: $I_c = \dfrac{20}{25}$

Step 4 – evaluate: $I_c = 0.8$

Final Answer: $I_c = 0.8 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept – primary consolidation settlement of a normally consolidated clay: $S_c = \dfrac{C_c\,H}{1+e_0}\log_{10}\dfrac{\sigma'_f}{\sigma'_0}$.

Step 1 – list the data: $C_c = 0.30$, $H = 4$ m, $e_0 = 0.80$, $\sigma'_0 = 100$ kPa, $\sigma'_f = 200$ kPa.

Step 2 – form the leading factor: $\dfrac{C_c\,H}{1+e_0} = \dfrac{0.30\times 4}{1+0.80}$

$= \dfrac{1.2}{1.8}$

$= 0.6667$ m

Step 3 – evaluate the log term: $\log_{10}\dfrac{200}{100} = \log_{10}2 = 0.301$

Step 4 – multiply: $S_c = 0.6667 \times 0.301$

$S_c = 0.2007$ m

Step 5 – express in millimetres: $S_c \approx 200$ mm

Final Answer: $S_c \approx 200 \text{ mm} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept – Rankine passive earth-pressure coefficient: $K_p = \dfrac{1+\sin\phi}{1-\sin\phi}$.

Step 1 – evaluate $\sin\phi$**:** $\sin 30^\circ = 0.5$

Step 2 – form the numerator: $1+\sin\phi = 1+0.5 = 1.5$

Step 3 – form the denominator: $1-\sin\phi = 1-0.5 = 0.5$

Step 4 – divide: $K_p = \dfrac{1.5}{0.5}$

$K_p = 3.0$

Step 5 – cross-check: The active coefficient is $K_a = 0.5/1.5 = 0.333$, and indeed $K_p = 1/K_a = 3.0$, as it should be.

Final Answer: $K_p = 3.0 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q22

Q23.

Solution

Concept – Terzaghi bearing capacity of a strip footing: $q_u = c'N_c + \gamma D_f N_q + 0.5\,\gamma B N_\gamma$; for cohesionless sand the first term vanishes.

Step 1 – drop the cohesion term: With $c' = 0$, $c'N_c = 0$.

Step 2 – evaluate the surcharge term: $\gamma D_f N_q = 18 \times 1.5 \times 18$

$= 27 \times 18$

$= 486$ kPa

Step 3 – evaluate the width term: $0.5\,\gamma B N_\gamma = 0.5 \times 18 \times 2 \times 15$

$= 18 \times 15$

$= 270$ kPa

Step 4 – add the contributions: $q_u = 0 + 486 + 270$

$q_u = 756$ kPa

Final Answer: $q_u = 756 \text{ kPa} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q23

Q24.

Solution

Concept – centre of pressure of a vertical surface touching the free surface: For a vertical rectangle with its top edge at the water surface, the centre of pressure lies at two-thirds of the depth from the surface, i.e. $h_{cp} = \frac{2}{3}d$.

Step 1 – locate the centroid: The centroid is at $\bar{h} = d/2 = 3/2 = 1.5$ m below the surface.

Step 2 – write the second-moment correction: $h_{cp} = \bar{h} + \dfrac{I_G}{A\,\bar{h}}$, with $I_G = \dfrac{b\,d^3}{12}$ and $A = b\,d$.

Step 3 – simplify the correction term: $\dfrac{I_G}{A\,\bar{h}} = \dfrac{bd^3/12}{(bd)(d/2)} = \dfrac{d}{6} = \dfrac{3}{6} = 0.5$ m

Step 4 – add: $h_{cp} = 1.5 + 0.5$

$h_{cp} = 2.0$ m

Step 5 – confirm with the shortcut: $\frac{2}{3}d = \frac{2}{3} \times 3 = 2.0$ m, which agrees.

Final Answer: $h_{cp} = 2.0 \text{ m} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept – Reynolds number for pipe flow: $Re = \dfrac{\rho V D}{\mu}$.

Step 1 – list the data: $\rho = 1000 \text{ kg/m}^3$, $V = 2$ m/s, $D = 0.10$ m, $\mu = 1.0 \times 10^{-3}$ Pa·s.

Step 2 – form the numerator: $\rho V D = 1000 \times 2 \times 0.10$

$= 200$

Step 3 – divide by the viscosity: $Re = \dfrac{200}{1.0 \times 10^{-3}}$

Step 4 – evaluate: $Re = 200000$

Step 5 – interpret: Since $Re > 4000$, the flow is turbulent.

Final Answer: $Re = 200000 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q25

Q26.

Solution

Concept – Manning's uniform-flow equation: $V = \dfrac{1}{n} R^{2/3} S^{1/2}$.

Step 1 – list the data: $n = 0.015$, $R = 1.0$ m, $S = 0.0001$.

Step 2 – evaluate $R^{2/3}$: $R^{2/3} = 1.0^{2/3} = 1.0$

Step 3 – evaluate $S^{1/2}$: $S^{1/2} = \sqrt{0.0001} = 0.01$

Step 4 – evaluate $1/n$: $\dfrac{1}{0.015} = 66.67$

Step 5 – multiply the three factors: $V = 66.67 \times 1.0 \times 0.01$

$V = 0.667$ m/s

Final Answer: $V \approx 0.67 \text{ m/s} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q26

Q27.

Solution

Concept – minimum specific energy at critical flow: For a rectangular channel the minimum specific energy is $E_{\min} = 1.5\, y_c$, where y_c is the critical depth.

Step 1 – list the data: $y_c = 1.2$ m.

Step 2 – substitute into $E_{\min} = 1.5\, y_c$**:** $E_{\min} = 1.5 \times 1.2$

Step 3 – evaluate: $E_{\min} = 1.8$ m

Step 4 – reason for the factor: At critical flow the velocity head is $y_c/2$, so $E_{\min} = y_c + y_c/2 = 1.5\, y_c$.

Final Answer: $E_{\min} = 1.8 \text{ m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q27

Q28.

Solution

Concept – Froude number of open-channel flow: $F_r = \dfrac{V}{\sqrt{g\, y}}$, where y is the flow depth.

Step 1 – list the data: $V = 6$ m/s, $y = 1$ m, $g = 9.81$ m/s^2.

Step 2 – evaluate the product $g\, y$**:** $g\, y = 9.81 \times 1 = 9.81$

Step 3 – take the square root: $\sqrt{9.81} = 3.132$

Step 4 – divide: $F_r = \dfrac{6}{3.132}$

$F_r = 1.92$

Step 5 – interpret: Since $F_r > 1$, the flow is supercritical.

Final Answer: $F_r \approx 1.92 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q28

Q29.

Solution

Concept – conjugate (sequent) depths across a hydraulic jump: $\dfrac{y_2}{y_1} = \dfrac{1}{2}\left(\sqrt{1 + 8F_1^2} - 1\right)$.

Step 1 – square the approach Froude number: $F_1^2 = 3.0^2 = 9$

Step 2 – form the quantity under the root: $1 + 8F_1^2 = 1 + 8 \times 9 = 1 + 72 = 73$

Step 3 – take the square root: $\sqrt{73} = 8.544$

Step 4 – subtract 1**:** $8.544 - 1 = 7.544$

Step 5 – halve: $\frac{y_2}{y_1} = \frac{7.544}{2}$

$\frac{y_2}{y_1} = 3.77$

Final Answer: $y_2/y_1 \approx 3.77 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept – power delivered to a liquid: $P = \rho g Q H = \gamma_w Q H$.

Step 1 – list the data: $\gamma_w = 9.81$ kN/m^3, $Q = 0.5$ m^3/s, $H = 20$ m.

Step 2 – multiply γ_w **by** Q**:** $9.81 \times 0.5 = 4.905$

Step 3 – multiply by the head: $P = 4.905 \times 20$

Step 4 – evaluate: $P = 98.1$ kW

Final Answer: $P = 98.1$ kW $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q30

Q31.

Solution

Concept – ϕ**-index as a uniform loss rate:** $\phi = \frac{\text{total rainfall} - \text{runoff}}{\text{duration}}$ (when rainfall intensity exceeds the loss rate throughout).

Step 1 – find the total rainfall depth: Intensity $\times$ duration $= 2 \times 3 = 6$ cm.

Step 2 – find the total loss (rainfall minus runoff): $6 - 3 = 3$ cm.

Step 3 – divide the loss by the storm duration: $\phi = \frac{3 \text{ cm}}{3 \text{ hr}}$

Step 4 – evaluate: $\phi = 1.0$ cm/hr

Step 5 – consistency check: The intensity (2 cm/hr) exceeds ϕ (1 cm/hr) throughout, so the uniform-loss assumption is valid.

Final Answer: $\phi = 1.0$ cm/hr $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept – transmissivity of a confined aquifer: $T = k\,b$, the permeability times the saturated thickness.

Step 1 – list the data: $k = 25$ m/day, $b = 20$ m.

Step 2 – multiply: $T = 25 \times 20$

Step 3 – evaluate: $T = 500\ \text{m}^2/\text{day}$

Final Answer: $T = 500\ \text{m}^2/\text{day} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q32

Q33.

Solution

Concept – frequency of irrigation: $\text{Interval} = \dfrac{\text{net depth applied}}{\text{consumptive-use rate}}$.

Step 1 – put the two quantities in the same units: Net depth $= 6$ cm $= 60$ mm; consumptive-use rate $= 3$ mm/day.

Step 2 – divide: $\text{Interval} = \dfrac{60}{3}$

Step 3 – evaluate: $\text{Interval} = 20$ days

Final Answer: frequency $= 20$ days $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q33

Q34.

Solution

Concept – probability of non-exceedance over several years: The probability that the event does not occur in a single year is $\left(1 - \frac{1}{T}\right)$; over n independent years it is $\left(1 - \frac{1}{T}\right)^n$.

Step 1 – find the annual exceedance probability: $p = \dfrac{1}{T} = \dfrac{1}{50} = 0.02$

Step 2 – find the annual non-exceedance probability: $1 - p = 1 - 0.02 = 0.98$

Step 3 – raise to the number of years: $(0.98)^2$

Step 4 – evaluate: $(0.98)^2 = 0.9604$

≈ 0.96

Final Answer: probability $\approx 0.96 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept – chlorine demand: Chlorine demand $=$ chlorine dose $-$ chlorine residual.

Step 1 – list the data: Dose $= 5.0$ mg/L, residual $= 0.5$ mg/L.

Step 2 – subtract: Demand $= 5.0 - 0.5$

Step 3 – evaluate: Demand $= 4.5$ mg/L

Final Answer: chlorine demand $= 4.5$ mg/L $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q35

Q36.

Solution

Concept – detention time of a tank: $t_d = \dfrac{V}{Q}$, the tank volume divided by the flow rate.

Step 1 – list the data: $V = 2000$ m^3, $Q = 4000$ m^3/day.

Step 2 – divide: $t_d = \dfrac{2000}{4000}$

$t_d = 0.5$ day

Step 3 – convert to hours: $t_d = 0.5 \times 24$

$t_d = 12$ hr

Final Answer: $t_d = 12$ hr $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept – filter area from flow and filtration rate: Area $= \dfrac{\text{flow rate}}{\text{filtration rate}}$.

Step 1 – convert the flow to litres per hour: 5 MLD $= 5{,}000{,}000$ L/day

$= \dfrac{5{,}000{,}000}{24}$ L/hr

$= 208{,}333$ L/hr

Step 2 – write the filtration rate: 5000 L/m^2/hr.

Step 3 – divide to get the area: Area $= \dfrac{208{,}333}{5000}$

Step 4 – evaluate: Area $= 41.7$ m^2

Final Answer: area ≈ 41.7 m^2 $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q37

Q38.

Solution

Concept – adding equal sound levels on the decibel scale: Doubling the acoustic power adds $10\log_{10} 2 \approx 3$ dB, so two equal sources give (level of one) $+3$ dB.

Step 1 – note the two levels are equal: Each source produces 60 dB, so the combined power is twice that of one source.

Step 2 – apply the $+3$ dB rule: Combined level $= 60 + 3$

Step 3 – evaluate: Combined level $= 63$ dB

Why the other options are wrong:

- A, 120: wrongly adds the decibel numbers arithmetically; decibels are logarithmic and cannot be added like that.
- C, 66: would correspond to four equal sources ($+6$ dB), not two.
- D, 60: ignores the extra energy contributed by the second source.

Final Answer: combined level $= 63$ dB $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q38

Q39.

Solution

Concept – volume reduction from compaction: For a fixed mass, volume is inversely proportional to density, so $\%$ reduction $= \left(1 - \dfrac{\rho_{\text{loose}}}{\rho_{\text{compacted}}}\right) \times 100$.

Step 1 – form the density ratio: $\dfrac{\rho_{\text{loose}}}{\rho_{\text{compacted}}} = \dfrac{100}{500} = 0.20$

Step 2 – this ratio is the fraction of the original volume that remains: Final volume $= 0.20\times$ initial volume.

Step 3 – find the fraction removed: $1 - 0.20 = 0.80$

Step 4 – express as a percentage: $\%$ reduction $= 0.80 \times 100 = 80\%$

Final Answer: volume reduction $= 80\% \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q39

Q40.

Solution

Concept – lag (reaction) distance: $d_{\text{lag}} = v\, t_r$, the speed in m/s times the reaction time.

Step 1 – convert the speed to m/s: $v = 72 \text{ km/h} = \dfrac{72}{3.6} \text{ m/s} = 20 \text{ m/s}$

Step 2 – write the reaction time: $t_r = 2.5$ s.

Step 3 – multiply: $d_{\text{lag}} = 20 \times 2.5$

Step 4 – evaluate: $d_{\text{lag}} = 50 \text{ m}$

Final Answer: lag distance $= 50 \text{ m} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q40

Q41.

Solution

Concept – deviation angle at a summit vertical curve: The deviation angle N is the algebraic difference of the grades, $N = g_1 - g_2$, with rising grades positive and falling grades negative.

Step 1 – express the grades as fractions: $g_1 = +3\% = +0.03$, $g_2 = -2\% = -0.02$.

Step 2 – take the algebraic difference: $N = g_1 - g_2 = 0.03 - (-0.02)$

Step 3 – remove the double sign: $N = 0.03 + 0.02$

Step 4 – evaluate: $N = 0.05$

Final Answer: $N = 0.05 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q41

Q42.

Solution

Concept – optimum speed in Greenshields' model: Maximum flow occurs at the optimum speed, which is half the free-flow speed, $V_o = \dfrac{V_f}{2}$.

Step 1 – list the data: $V_f = 60$ km/h.

Step 2 – halve the free-flow speed: $V_o = \dfrac{60}{2}$

Step 3 – evaluate: $V_o = 30$ km/h

Step 4 – note: The jam density value (120 veh/km) is not needed to find the optimum *speed*; it would only be needed for the actual capacity in veh/hr.

Final Answer: $V_o = 30$ km/h $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q42

Q43.

Solution

Concept – back bearing from fore bearing: Back bearing = fore bearing $\pm 180°$; add $180°$ if the fore bearing is less than $180°$.

Step 1 – note the fore bearing: FB $= 120°$, which is less than $180°$.

Step 2 – add $180°$: BB $= 120° + 180°$

Step 3 – evaluate: BB $= 300°$

Step 4 – range check: $300°$ is within $0°$–$360°$, so no further adjustment is needed.

Final Answer: back bearing $= 300° \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q43

Q44.

Solution

Concept – correction for an incorrect chain length: True length $=$ Measured length $\times \dfrac{\text{actual chain length}}{\text{nominal chain length}}$.

Step 1 – form the length ratio: $\dfrac{\text{actual}}{\text{nominal}} = \dfrac{30.1}{30}$ $= 1.00333$

Step 2 – multiply the measured length by the ratio: True length $= 900 \times 1.00333$

Step 3 – evaluate: True length $= 903$ m

Step 4 – sense check: A chain that is too long records *fewer* chain lengths than the true distance, so the true length is larger than the measured value, consistent with $903 > 900$.

Final Answer: true length $= 903$ m $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q44

Q45.

Solution

Concept – latitude of a survey line: Latitude $= L\cos\theta$, the projection of the line on the north–south axis.

Step 1 – list the data: $L = 100$ m, $\theta = 30°$.

Step 2 – evaluate the cosine: $\cos 30° = 0.866$

Step 3 – multiply: Latitude $= 100 \times 0.866$

Step 4 – evaluate: Latitude $= 86.6$ m

Final Answer: latitude $= 86.6$ m $\Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q45**

Q46.

Solution

Concept – tangent length of a simple circular curve: $T = R\tan\frac{\Delta}{2}$, where Δ is the deflection angle.

Step 1 – list the data: $R = 200$ m, $\Delta = 60°$.

Step 2 – halve the deflection angle: $\frac{\Delta}{2} = \frac{60°}{2} = 30°$

Step 3 – evaluate the tangent: $\tan 30° = 0.5774$

Step 4 – multiply by the radius: $T = 200 \times 0.5774$

Step 5 – evaluate: $T = 115.47$ m

Final Answer: $T = 115.47$ m $\Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q46**

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	D	4	D	5	C
6	A	7	B	8	C	9	D	10	B
11	D	12	B	13	A	14	C	15	D
16	B	17	A	18	D	19	C	20	D
21	A	22	D	23	A	24	D	25	C
26	C	27	A	28	B	29	B	30	C
31	C	32	B	33	C	34	B	35	A
36	C	37	B	38	B	39	A	40	B
41	D	42	D	43	A	44	C	45	A
46	A								