GATE Civil Engineering

Sample Paper – 9

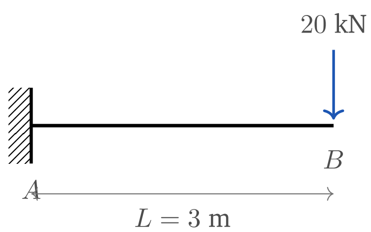
Duration: 128 Minutes | **Maximum Marks: 72**

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



(A) 20 kN·m

(B) 30 kN·m

(C) 40 kN·m

(D) 60 kN·m

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

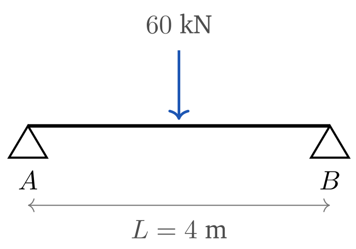
(A) 1.0 mm

(B) 0.5 mm

(C) 2.0 mm

(D) 0.25 mm

Q3. A simply supported beam of span 4 m carries a single concentrated load of 60 kN at its midspan, as shown. The maximum bending moment in the beam is: **[1 mark]**



(A) 60 kN·m

(B) 30 kN·m

(C) 120 kN·m

(D) 15 kN·m

Q4. For a certain elastic material the modulus of elasticity is $E = 200$ GPa and the shear modulus is $G = 80$ GPa. Using $E = 2G(1 + \mu)$, Poisson's ratio μ of the material is: **[1 mark]**

(A) 0.50

(B) 0.30

(C) 0.20

(D) 0.25

Q5. A steel bar is held rigidly between two immovable supports so that it cannot expand. Its temperature is raised by 30°C. Taking the coefficient of thermal expansion $\alpha = 12 \times 10^{-6}/°\text{C}$ and $E = 200$ GPa, the thermal (compressive) stress induced in the bar is: **[1 mark]**

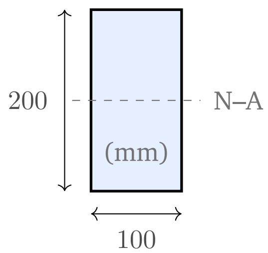
(A) 72 MPa

(B) 36 MPa

(C) 144 MPa

(D) 60 MPa

Q6. A solid rectangular cross-section is 100 mm wide and 200 mm deep, as shown. The moment of inertia of the section about its horizontal centroidal axis is: **[1 mark]**



(A) 6.67×10^7 mm^4

(B) 3.33×10^7 mm^4

(C) 1.33×10^8 mm^4

(D) 2.0×10^7 mm^4

Q7. A cantilever beam of length L and flexural rigidity EI carries a single concentrated load W at its free end. The maximum vertical deflection of the beam (at the free end) is: **[1 mark]**

(A) $\dfrac{WL^3}{48EI}$

(B) $\dfrac{WL^3}{3EI}$

(C) $\dfrac{5wL^4}{384EI}$

(D) $\dfrac{WL^3}{8EI}$

Q8. A straight column is fixed (restrained against rotation and translation) at one end and completely free at the other (a flagpole condition). For use in the Euler buckling formula, the effective length of this column is: **[1 mark]**

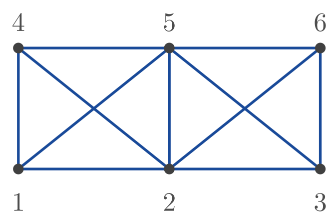
(A) $0.5\,L$

(B) $1.0\,L$

(C) $2.0\,L$

(D) $0.707\,L$

Q9. The plane truss shown below has $j = 6$ joints, $m = 11$ members and $r = 3$ external reaction components. The degree of static indeterminacy of the truss, $D_s = (m + r) - 2j$, is: **[1 mark]**



(A) 0

(B) 1

(C) 2

(D) 3

Q10. A beam of span 8 m is fixed at both ends and carries a single concentrated load of 24 kN at its midspan. The magnitude of the fixed-end moment developed at each support, $WL/8$, is: **[1 mark]**

(A) 48 kN·m

(B) 12 kN·m

(C) 16 kN·m

(D) 24 kN·m

Q11. In the moment-distribution method, a moment is applied at one end of a prismatic member whose far end is fixed. The carry-over factor, that is the fraction of the applied moment carried over to the fixed far end, is: **[1 mark]**

(A) 1.00

(B) 0.50

(C) 0.25

(D) 0.75

Q12. In the working stress method of IS 456:2000 the modular ratio is taken as $m = \dfrac{280}{3\,\sigma_{cbc}}$, where σ_{cbc} is the permissible bending compressive stress in concrete. For M20 concrete, $\sigma_{cbc} = 7$ N/mm^2. The modular ratio is nearest to: **[1 mark]**

(A) 13.33

(B) 9.33

(C) 18.67

(D) 280

Q13. As per the limit state method of IS 456:2000 for reinforced concrete, the partial safety factor applied to the characteristic strength of **concrete**, γ_c, in computing design strength is: **[1 mark]**

(A) 1.15

(B) 1.50

(C) 1.00

(D) 1.25

Q14. In a construction project network, a certain activity has an earliest start time EST $= 5$ days and a latest start time LST $= 9$ days. The total float available for this activity is: **[1 mark]**

(A) 14 days

(B) 9 days

(C) 5 days

(D) 4 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) 20.0 kN/m^3

(C) 15.0 kN/m^3

(D) 16.0 kN/m^3

Q16. A sand deposit has a maximum void ratio $e_{\text{max}} = 0.90$, a minimum void ratio $e_{\text{min}} = 0.40$ and an in-situ (natural) void ratio $e = 0.65$. The relative density (density index) of the sand is: **[1 mark]**

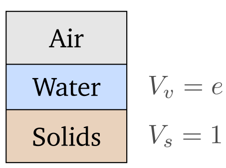
(A) 25%

(B) 75%

(C) 50%

(D) 40%

Q17. A soil has a dry unit weight of 16 kN/m^3 and a specific gravity of solids $G = 2.70$. Using the three-phase relation $\gamma_d = \dfrac{G\,\gamma_w}{1+e}$ (with $\gamma_w = 9.81$ kN/m^3) and the phase diagram shown, the void ratio of the soil is nearest to: **[1 mark]**



(A) 0.30

(B) 1.65

(C) 2.70

(D) 0.66

Q18. A soil deposit has its water table at a depth of 2 m below the ground surface. Above the water table the moist unit weight is 17 kN/m^3 and below it the saturated unit weight is 20 kN/m^3. The effective vertical stress at a depth of 5 m below the surface is nearest to: **[1 mark]**

(A) 94.00 kN/m^2

(B) 90.00 kN/m^2

(C) 64.57 kN/m^2

(D) 45.00 kN/m^2

Q19. In a laboratory permeameter, water flows through a soil under a hydraulic gradient of 0.5. The coefficient of permeability of the soil is 0.02 cm/s. The Darcy (discharge) velocity of flow is: **[1 mark]**

(A) 0.04 cm/s

(B) 0.02 cm/s

(C) 0.50 cm/s

(D) 0.01 cm/s

Q20. According to Terzaghi's one-dimensional consolidation theory, for an average degree of consolidation $U = 50\%$ the time factor is given by $T_v = \frac{\pi}{4}U^2$. The value of T_v corresponding to $U = 50\%$ is nearest to: **[1 mark]**

(A) 0.500

(B) 0.848

(C) 1.000

(D) 0.197

Geotechnical Engineering (continued)

Q21. A normally consolidated clay layer 4 m thick has a compression index $C_c = 0.30$ and an initial void ratio $e_0 = 0.80$. The initial effective vertical stress at the middle of the layer is 100 kPa, and a wide surcharge raises it by 100 kPa. The primary consolidation settlement, $S = \dfrac{C_c H}{1+e_0}\log_{10}\dfrac{\sigma_0 + \Delta\sigma}{\sigma_0}$, is nearest to: **[2 marks]**

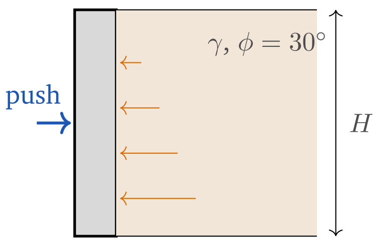
(A) 200 mm

(B) 100 mm

(C) 301 mm

(D) 150 mm

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



(A) 0.333

(B) 1.000

(C) 0.500

(D) 3.000

Q23. A square footing of size 2 m $\times$ 2 m rests on a soil for which the net safe bearing capacity has been found to be 150 kN/m^2. Neglecting the self-weight of the footing and any surcharge, the maximum net column load the footing can safely support is: **[2 marks]**

(A) 150 kN

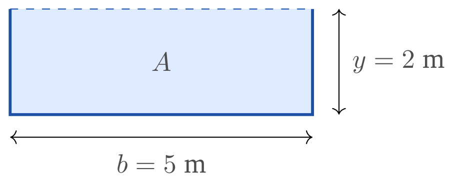
(B) 300 kN

(C) 600 kN

(D) 75 kN

Water Resources Engineering

Q24. A rectangular open channel of width 5 m carries water at a depth of 2 m, as shown. The hydraulic radius (hydraulic mean depth) of the flow section is: **[2 marks]**



(A) 1.11 m

(B) 2.00 m

(C) 0.90 m

(D) 5.00 m

Q25. A vertical rectangular gate 2 m wide and 3 m deep has its top edge coinciding with the free water surface on one side. Measured from the free surface, the depth of the centre of pressure on the gate is: **[2 marks]**

(A) 2.00 m

(B) 1.50 m

(C) 1.00 m

(D) 3.00 m

Q26. Water flows steadily through a pipe of diameter 100 mm at a mean velocity of 4 m/s. The volumetric discharge through the pipe is nearest to: **[2 marks]**

(A) 12.6 L/s

(B) 31.4 L/s

(C) 62.8 L/s

(D) 15.7 L/s

Q27. Water of kinematic viscosity 1×10^{-6} m^2/s flows through a pipe of diameter 50 mm at a mean velocity of 2 m/s. The Reynolds number of the flow, $Re = \dfrac{VD}{\nu}$, is: **[2 marks]**

(A) 10,000

(B) 100,000

(C) 1,000

(D) 50,000

Q28. In a wide rectangular channel the mean velocity of flow is 3 m/s at a flow depth of 0.9 m. The Froude number of the flow, $Fr = \dfrac{V}{\sqrt{gy}}$, is nearest to (and hence the flow is close to critical): **[2 marks]**

(A) 1.01

(B) 0.50

(C) 2.00

(D) 1.50

Q29. A horizontal jet of water of diameter 30 mm moving at 20 m/s strikes a large stationary flat plate held normal to the jet. Taking $\rho_w = 1000$ kg/m^3, the force exerted by the jet on the plate, $F = \rho_w A V^2$, is nearest to: **[2 marks]**

(A) 141.4 N

(B) 565.5 N

(C) 282.7 N

(D) 70.7 N

Q30. A catchment of area 3 km^2 has a runoff coefficient of 0.50. For a design rainfall intensity of 36 mm/hr, the peak runoff estimated by the rational method $\left(Q = CiA/3.6\right)$ is: **[2 marks]**

(A) $54.0\ \text{m}^3/\text{s}$

(B) $30.0\ \text{m}^3/\text{s}$

(C) $15.0\ \text{m}^3/\text{s}$

(D) $7.5\ \text{m}^3/\text{s}$

Q31. A 6-hour unit hydrograph is derived for a catchment of area $100\ \text{km}^2$. Since a unit hydrograph represents 1 cm of effective (excess) rainfall spread over the whole catchment, the total volume of direct runoff under the unit hydrograph is: **[2 marks]**

(A) $1 \times 10^5\ \text{m}^3$

(B) $1 \times 10^6\ \text{m}^3$

(C) $1 \times 10^7\ \text{m}^3$

(D) $1 \times 10^4\ \text{m}^3$

Q32. For a certain crop the duty of irrigation water is 864 hectares per cumec and the base period is 90 days. Using $\Delta = \dfrac{8.64\,B}{D}$ (with Δ in metres, B in days, D in ha/cumec), the delta for the crop is: **[2 marks]**

(A) 120 cm

(B) 60 cm

(C) 90 cm

(D) 100 cm

Q33. A field of 100 hectares is to be irrigated for a crop whose duty at the head of the field is 800 hectares per cumec. The discharge that must be supplied continuously to irrigate the whole field is: **[2 marks]**

(A) $0.800\ \text{m}^3/\text{s}$

(B) $0.125\ \text{m}^3/\text{s}$

(C) $8.000\ \text{m}^3/\text{s}$

(D) $1.250\ \text{m}^3/\text{s}$

Q34. A hydraulic structure is designed for a service life of 2 years against a flood whose return period is 10 years. The risk (probability of at least one exceedance during the life), $R = 1 - \left(1 - \frac{1}{T}\right)^n$, is: **[2 marks]**

(A) 0.10

(B) 0.19

(C) 0.20

(D) 0.01

Environmental Engineering

Q35. A wastewater has an ultimate (first-stage) BOD of 250 mg/L and a deoxygenation rate constant $k = 0.23$ day^{-1} (to base e). Using $\text{BOD}_t = L_0\left(1 - e^{-kt}\right)$, the 3-day BOD of the sample is nearest to: **[2 marks]**

(A) 250 mg/L

(B) 88 mg/L

(C) 125 mg/L

(D) 200 mg/L

Q36. A sedimentation tank of effective volume 800 m^3 treats a steady flow of 4000 m^3/day. The theoretical detention (retention) time of the tank is: **[2 marks]**

(A) 2.4 hours

(B) 9.6 hours

(C) 4.8 hours

(D) 0.2 hours

Q37. A town has a population of 1,00,000. Taking the average per-capita water demand as 150 litres per capita per day, the average daily water demand of the town is: **[2 marks]**

(A) 15,000 m^3/day

(B) 1,500 m^3/day

(C) 1,50,000 m^3/day

(D) 6,750 m^3/day

Q38. In the disinfection of water, chlorine is applied at a dose of 5.0 mg/L and the free residual chlorine measured after the contact period is 0.5 mg/L. The chlorine demand of the water is: **[2 marks]**

(A) 5.5 mg/L

(B) 4.5 mg/L

(C) 5.0 mg/L

(D) 0.5 mg/L

Q39. A city generates 300 tonnes per day of municipal solid waste. The average compacted density of the waste in the collection vehicles is 500 kg/m^3. The daily volume of waste to be transported is: **[2 marks]**

(A) 1,50,000 m^3/day

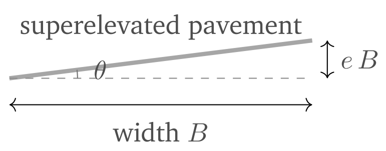
(B) 1,500 m^3/day

(C) 125 m^3/day

(D) 600 m^3/day

Transportation & Geomatics Engineering

Q40. A horizontal highway curve of radius 200 m is designed for a speed of 72 km/h. The pavement is superelevated as shown. The sum of the superelevation and the side-friction factor $(e+f)$ required to balance the centrifugal effect, using $e+f = V^2/(127R)$ (with V in km/h, R in m), is: **[2 marks]**



(A) 0.10

(B) 0.20

(C) 0.40

(D) 0.05

Q41. A vehicle travels at a design speed of 36 km/h on a level road. The driver's reaction (perception–brake) time is 2.5 s and the longitudinal friction coefficient is 0.35 (take $g = 9.81$ m/s^2). The stopping sight distance required is nearest to: **[2 marks]**

(A) 25.0 m

(B) 39.6 m

(C) 14.6 m

(D) 50.0 m

Q42. A traffic stream follows Greenshields' linear speed–density model with a free-flow speed of 80 km/h. The speed at which the traffic flow (volume) is a maximum is: **[2 marks]**

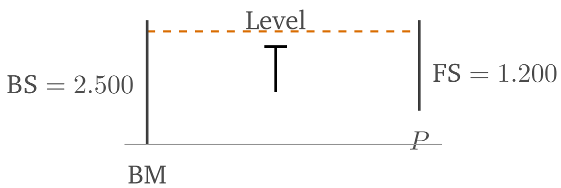
(A) 80 km/h

(B) 20 km/h

(C) 160 km/h

(D) 40 km/h

Q43. In differential levelling, a level is set up between a benchmark and a point P, as shown. The reduced level of the benchmark is 150.000 m, the back sight reading on it is 2.500 m and the fore sight reading on P is 1.200 m. The reduced level of P is: **[2 marks]**



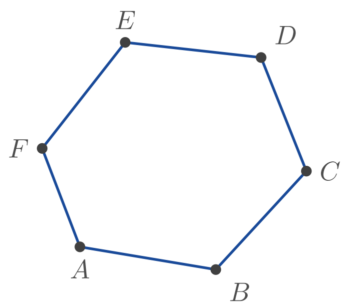
(A) 148.700 m

(B) 151.300 m

(C) 153.700 m

(D) 150.000 m

Q44. A closed traverse has the shape of a six-sided polygon (hexagon), as shown. For the traverse to close correctly, the theoretical sum of its interior angles, $(2n - 4) \times 90°$, should be: **[2 marks]**



(A) 360°

(B) 540°

(C) 720°

(D) 900°

Q45. A simple circular curve of radius 200 m has a deflection (intersection) angle of 90°. The tangent length of the curve, $T = R\tan(\Delta/2)$, is: **[2 marks]**

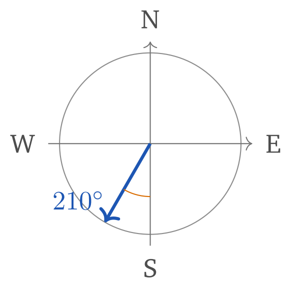
(A) 200.0 m

(B) 282.8 m

(C) 314.2 m

(D) 100.0 m

Q46. The whole-circle bearing of a survey line is 210°, as shown on the compass diagram. The corresponding reduced (quadrantal) bearing of the line is: **[2 marks]**



(A) S30°W

(B) N30°E

(C) S60°W

(D) N60°W

Detailed Solutions

Q1.

Solution

Concept – maximum bending moment in a cantilever with an end point load: For a cantilever carrying a single load at the free end, the bending moment grows linearly and is largest at the fixed support.

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

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

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 $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q1

Q2.

Solution

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

Step 1 – convert all quantities to consistent units: $P = 50 \text{ kN} = 50000 \text{ N}$

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

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

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

Step 2 – substitute into the formula: $\delta = \dfrac{50000 \times 2000}{500 \times 200000}$

Step 3 – evaluate the numerator: $50000 \times 2000 = 1.0 \times 10^8$

Step 4 – evaluate the denominator: $500 \times 200000 = 1.0 \times 10^8$

Step 5 – divide: $\delta = \dfrac{1.0 \times 10^8}{1.0 \times 10^8} = 1.0$ mm

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

Answer: (A) Go Back to Q2

Q3.

Solution

Concept – maximum moment for a central point load on a simply supported beam: $M_{\max} = \frac{WL}{4}$, occurring directly under the load at midspan.

Step 1 – list the data: $W = 60$ kN, $L = 4$ m.

Step 2 – substitute into the formula: $M_{\max} = \frac{60 \times 4}{4}$

Step 3 – evaluate the numerator: $60 \times 4 = 240$

Step 4 – divide by 4**:** $M_{\max} = \frac{240}{4} = 60$ kN·m

Step 5 – sanity check: Each reaction is $W/2 = 30$ kN; the midspan moment is $30 \times 2 = 60$ kN·m, which agrees.

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

Answer: (A) Go Back to Q3

Q4.

Solution

Concept – elastic-constant relation between E**,** G **and** μ**:** $E = 2G(1+\mu)$, so $\mu = \frac{E}{2G} - 1$.

Step 1 – list the data: $E = 200$ GPa, $G = 80$ GPa.

Step 2 – form the ratio $E/(2G)$**:** $\frac{E}{2G} = \frac{200}{2 \times 80}$

Step 3 – evaluate the denominator: $2 \times 80 = 160$

Step 4 – complete the ratio: $\frac{200}{160} = 1.25$

Step 5 – subtract 1**:** $\mu = 1.25 - 1 = 0.25$

Final Answer: $\mu = 0.25 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept – thermal stress in a fully restrained bar: When free expansion is completely prevented, the induced stress is $\sigma = \alpha\, E\, \Delta T$.

Step 1 – list the data: $\alpha = 12 \times 10^{-6}/°\text{C}$, $E = 200$ GPa $= 200000$ N/mm^2, $\Delta T = 30°\text{C}$.

Step 2 – multiply E **by** ΔT**:** $E\,\Delta T = 200000 \times 30 = 6.0 \times 10^6$

Step 3 – multiply by α: $\sigma = 12 \times 10^{-6} \times 6.0 \times 10^{6}$

Step 4 – combine the powers of ten: $\sigma = 12 \times 6.0 \times 10^{-6+6}$

Step 5 – evaluate: $\sigma = 72 \times 10^{0} = 72\ \text{N/mm}^2 = 72\ \text{MPa}$

Final Answer: $\sigma = 72\ \text{MPa} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept – moment of inertia of a rectangle about its centroidal axis: $I = \dfrac{b\,d^3}{12}$, with b the width and d the depth measured parallel to the bending.

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

Step 2 – evaluate d^3: $200^3 = 8.0 \times 10^6\ \text{mm}^3$

Step 3 – multiply by b: $b\,d^3 = 100 \times 8.0 \times 10^6 = 8.0 \times 10^8$

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

Step 5 – evaluate: $I = 6.67 \times 10^7\ \text{mm}^4$

Final Answer: $I = 6.67 \times 10^7\ \text{mm}^4 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept – standard deflection result for a cantilever with an end load: For a cantilever carrying a concentrated load W at the free end, the maximum deflection occurs at the free end.

Step 1 – recall the standard formula: $\delta_{\max} = \dfrac{WL^3}{3EI}$

Step 2 – confirm the dependence: The deflection grows with the cube of the length L^3 and falls with the flexural rigidity EI, which matches option B.

Why the other options are wrong:

- A, $WL^3/48EI$: is the midspan deflection of a **simply supported** beam under a central point load.
- C, $5wL^4/384EI$: is the midspan deflection under a **uniformly distributed** load w.
- D, $WL^3/8EI$: is the free-end deflection of a cantilever under a **uniformly**

distributed load, not an end point load.

Final Answer: $\delta_{\max} = \dfrac{WL^3}{3EI} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept – effective length depends on the end restraints: $L_e = k\,L$, where k is set by how the two ends are held.

Step 1 – identify the end conditions: One end is **fixed** and the other is **free** (a cantilever column, or flagpole).

Step 2 – recall the factor for fixed–free: $k = 2.0$

Step 3 – write the effective length: $L_e = 2.0\,L$

Why the other options are wrong:

- A, $0.5L$: applies to a column **fixed at both ends.**
- B, $1.0L$: applies to a column **hinged at both ends.**
- D, $0.707L$: applies to a column **fixed at one end and hinged at the other.**

Final Answer: $L_e = 2.0L \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept – degree of static indeterminacy of a plane truss: $D_s = (m + r) - 2j$, where m is the number of members, r the reaction components and j the number of joints.

Step 1 – read the data from the figure: $m = 11$, $r = 3$, $j = 6$.

Step 2 – add the members and reactions: $m + r = 11 + 3 = 14$

Step 3 – compute $2j$: $2j = 2 \times 6 = 12$

Step 4 – subtract: $D_s = 14 - 12 = 2$

Step 5 – interpret: $D_s = 2 > 0$, so the truss is statically indeterminate to the second degree (it has two redundant members).

Final Answer: $D_s = 2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept – fixed-end moment for a central point load on a fixed beam: For a beam fixed at both ends with a central load W, the magnitude of the moment at each support is $\dfrac{WL}{8}$.

Step 1 – list the data: $W = 24$ kN, $L = 8$ m.

Step 2 – substitute into the formula: $M = \dfrac{24 \times 8}{8}$

Step 3 – evaluate the numerator: $24 \times 8 = 192$

Step 4 – divide by 8**:** $M = \dfrac{192}{8} = 24$ kN·m

Final Answer: $M = 24$ kN·m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q10

Q11.

Solution

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

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

Step 2 – state the standard value: For a prismatic member with a fixed far end, this factor is 0.5.

Step 3 – reasoning: Applying a unit moment at the near end of a prismatic beam produces a moment of one half at the fixed far end, hence 0.5.

Why the other options are wrong:

- A, 1.00: would imply the whole moment is transferred, which is not the case for a prismatic member.
- C, 0.25 and D, 0.75: are not the 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 Q11

Q12.

Solution

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

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

Step 2 – evaluate 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: $m = 13.33 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept – partial safety factors for material strength in IS 456 limit state design: The design strength is the characteristic strength divided by the partial safety factor γ_m, and the value differs for concrete and steel.

Step 1 – recall the standard value for concrete: For concrete, $\gamma_c = 1.50$.

Step 2 – distinguish it from the steel value: For reinforcing steel the factor is $\gamma_s = 1.15$, which is a different case.

Why the other options are wrong:

- A, 1.15: is the factor for **reinforcing steel**, not concrete.
- C, 1.00: implies no safety margin and is not used for material strength.
- D, 1.25: is not the IS 456 material factor for concrete.

Final Answer: $\gamma_c = 1.50 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept – total float of an activity: Total float $=$ LST $-$ EST (equivalently the latest finish minus the earliest finish).

Step 1 – list the data: EST $= 5$ days, LST $= 9$ days.

Step 2 – subtract: Total float $= 9 - 5$

Step 3 – evaluate: Total float $= 4$ days

Step 4 – interpret: The activity can be delayed by up to 4 days without delaying the overall project completion.

Final Answer: total float $= 4$ days $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q14

Q15.

Solution

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

Step 1 – list the data: $\gamma = 20$ kN/m^3, $w = 25\% = 0.25$.

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

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

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

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

Answer: (D) Go Back to Q15

Q16.

Solution

Concept – relative density (density index): $I_D = \dfrac{e_{\max} - e}{e_{\max} - e_{\min}}$, comparing the in-situ void ratio with the loosest and densest states.

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

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

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

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

Step 5 – express as a percentage: $I_D = 50\%$

Final Answer: $I_D = 50\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q16

Q17.

Solution

Concept – void ratio from dry unit weight and specific gravity: $\gamma_d = \dfrac{G\,\gamma_w}{1+e}$, so $1+e = \dfrac{G\,\gamma_w}{\gamma_d}$.

Step 1 – list the data: $\gamma_d = 16$ kN/m^3, $G = 2.70$, $\gamma_w = 9.81$ kN/m^3.

Step 2 – compute the numerator $G\,\gamma_w$: $G\,\gamma_w = 2.70 \times 9.81 = 26.487$

Step 3 – divide by γ_d: $1+e = \dfrac{26.487}{16} = 1.655$

Step 4 – subtract 1: $e = 1.655 - 1 = 0.655$

Step 5 – round: $e \approx 0.66$

Final Answer: $e \approx 0.66 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q17

Q18.

Solution

Concept – effective stress with a water table below the surface: Effective stress $\sigma' = \sigma - u$, where σ is the total vertical stress and u the pore water pressure.

Step 1 – compute the total stress at 5 m depth: Above the water table (top 2 m): $17 \times 2 = 34$ kN/m^2

Below the water table (3 m of saturated soil): $20 \times 3 = 60$ kN/m^2

$\sigma = 34 + 60 = 94$ kN/m^2

Step 2 – compute the pore water pressure at 5 m: Water stands $5 - 2 = 3$ m above the point.

$u = \gamma_w \times 3 = 9.81 \times 3 = 29.43$ kN/m^2

Step 3 – subtract to get the effective stress: $\sigma' = 94 - 29.43$

Step 4 – evaluate: $\sigma' = 64.57$ kN/m^2

Final Answer: $\sigma' = 64.57$ kN/m$^2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept – Darcy's law for the discharge velocity: $v = k\,i$, where k is the coefficient of permeability and i the hydraulic gradient.

Step 1 – list the data: $k = 0.02$ cm/s, $i = 0.5$.

Step 2 – substitute into Darcy's law: $v = 0.02 \times 0.5$

Step 3 – evaluate: $v = 0.01$ cm/s

Step 4 – note: This is the discharge (Darcy) velocity across the gross area, not the higher seepage velocity through the voids.

Final Answer: $v = 0.01$ cm/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept – time factor for early consolidation ($U \le 60\%$): $T_v = \frac{\pi}{4}U^2$, with U expressed as a fraction.

Step 1 – list the data: $U = 50\% = 0.50.$

Step 2 – square U: $U^2 = 0.50^2 = 0.25$

Step 3 – evaluate $\pi/4$: $\frac{\pi}{4} = 0.7854$

Step 4 – multiply: $T_v = 0.7854 \times 0.25$

Step 5 – evaluate: $T_v = 0.196 \approx 0.197$

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

Answer: (D) Go Back to Q20

Q21.

Solution

Concept – primary consolidation settlement of a normally consolidated clay: $S = \frac{C_c\,H}{1+e_0}\log_{10}\frac{\sigma_0 + \Delta\sigma}{\sigma_0}.$

Step 1 – list the data: $C_c = 0.30$, $H = 4$ m, $e_0 = 0.80$, $\sigma_0 = 100$ kPa, $\Delta\sigma = 100$ kPa.

Step 2 – form the coefficient $\frac{C_cH}{1+e_0}$: $\frac{0.30 \times 4}{1+0.80} = \frac{1.20}{1.80}$

Step 3 – evaluate the coefficient: $\dfrac{1.20}{1.80} = 0.6667$ m

Step 4 – form the stress ratio: $\dfrac{\sigma_0 + \Delta\sigma}{\sigma_0} = \dfrac{100 + 100}{100} = 2$

Step 5 – take the logarithm: $\log_{10}(2) = 0.3010$

Step 6 – multiply: $S = 0.6667 \times 0.3010$

Step 7 – evaluate: $S = 0.2007$ m $= 200.7$ mm ≈ 200 mm

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

$\boxed{\text{Answer: (A)}}$ **Go Back to Q21**

Q22.

Solution

Concept – Rankine coefficient of passive earth pressure: $K_p = \dfrac{1 + \sin\phi}{1 - \sin\phi}$ for a smooth vertical wall and horizontal cohesionless backfill.

Step 1 – list the data: $\phi = 30°$, so $\sin\phi = 0.5$.

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

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

Step 4 – divide: $K_p = \dfrac{1.5}{0.5} = 3$

Step 5 – check: $K_p = 3$ is the reciprocal of the active coefficient $K_a = 1/3$ for $\phi = 30°$, as expected.

Final Answer: $K_p = 3 \Rightarrow \boxed{\text{D}}$

$\boxed{\text{Answer: (D)}}$ **Go Back to Q22**

Q23.

Solution

Concept – safe load from net safe bearing capacity: The net safe column load equals the net safe bearing capacity times the plan area of the footing.

Step 1 – compute the plan area of the footing: $A = 2 \times 2 = 4$ m^2

Step 2 – list the net safe bearing capacity: $q_{ns} = 150$ kN/m^2

Step 3 – multiply capacity by area: $Q = q_{ns} \times A = 150 \times 4$

Step 4 – evaluate: $Q = 600$ kN

Final Answer: $Q = 600$ kN $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept – hydraulic radius of a rectangular channel: $R = \frac{A}{P}$, where A is the flow area and P the wetted perimeter.

Step 1 – compute the flow area: $A = b \times y = 5 \times 2 = 10 \text{ m}^2$

Step 2 – compute the wetted perimeter: The water touches the bed ($b = 5$ m) and the two side walls (each of depth $y = 2$ m).

$P = b + 2y = 5 + 2 \times 2$

$P = 5 + 4 = 9 \text{ m}$

Step 3 – divide: $R = \frac{A}{P} = \frac{10}{9}$

Step 4 – evaluate: $R = 1.11 \text{ m}$

Final Answer: $R = 1.11 \text{ m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept – centre of pressure on a vertical surface from the free surface: For a vertical rectangle of depth d with its top edge at the water surface, the centre of pressure lies at $\bar{h} = \frac{2d}{3}$ below the surface.

Step 1 – list the data: Depth of gate $d = 3$ m (top edge at the free surface).

Step 2 – apply the centre-of-pressure result: $\bar{h} = \frac{2d}{3} = \frac{2 \times 3}{3}$

Step 3 – evaluate the numerator: $2 \times 3 = 6$

Step 4 – divide by 3: $\bar{h} = \frac{6}{3} = 2.0 \text{ m}$

Step 5 – interpret: The centre of pressure is below the centroid (at 1.5 m), as expected for a submerged pressure distribution.

Final Answer: $\bar{h} = 2.0 \text{ m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept – discharge from area and velocity: $Q = A \times V$, with A the cross-sectional area of the pipe.

Step 1 – convert the diameter: $D = 100$ mm $= 0.10$ m.

Step 2 – compute the pipe area: $A = \frac{\pi}{4}D^2 = \frac{\pi}{4}(0.10)^2$

$A = 0.7854 \times 0.01 = 0.007854$ m^2

Step 3 – multiply by the velocity: $Q = 0.007854 \times 4$

Step 4 – evaluate: $Q = 0.03142$ m^3/s

Step 5 – convert to litres per second: $Q = 0.03142 \times 1000 = 31.4$ L/s

Final Answer: $Q = 31.4$ L/s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept – Reynolds number for pipe flow: $Re = \dfrac{V\,D}{\nu}$, where V is the mean velocity, D the diameter and ν the kinematic viscosity.

Step 1 – list the data: $V = 2$ m/s, $D = 50$ mm $= 0.05$ m, $\nu = 1 \times 10^{-6}$ m^2/s.

Step 2 – compute the numerator $V\,D$**:** $V\,D = 2 \times 0.05 = 0.10$

Step 3 – divide by ν**:** $Re = \dfrac{0.10}{1 \times 10^{-6}}$

Step 4 – evaluate: $Re = 1 \times 10^5 = 100{,}000$

Step 5 – interpret: $Re \gg 4000$, so the flow is turbulent.

Final Answer: $Re = 100{,}000 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept – Froude number of open-channel flow: $Fr = \dfrac{V}{\sqrt{g\,y}}$; $Fr = 1$ marks the critical state.

Step 1 – list the data: $V = 3$ m/s, $y = 0.9$ m, $g = 9.81$ m/s^2.

Step 2 – compute $g\,y$**:** $g\,y = 9.81 \times 0.9 = 8.829$

Step 3 – take the square root: $\sqrt{8.829} = 2.971$ m/s

Step 4 – divide the velocity by this: $Fr = \dfrac{3}{2.971}$

Step 5 – evaluate: $Fr = 1.01$

Step 6 – interpret: $Fr \approx 1$, so the flow is essentially critical.

Final Answer: $Fr \approx 1.01 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q28

Q29.

Solution

Concept – force of a jet on a stationary normal flat plate: $F = \rho_w\, A\, V^2$, where A is the cross-sectional area of the jet.

Step 1 – convert the diameter: $d = 30$ mm $= 0.03$ m.

Step 2 – compute the jet area: $A = \dfrac{\pi}{4}d^2 = \dfrac{\pi}{4}(0.03)^2$

$A = 0.7854 \times 0.0009 = 7.069 \times 10^{-4}$ m^2

Step 3 – square the velocity: $V^2 = 20^2 = 400$ m^2/s^2

Step 4 – assemble the force: $F = 1000 \times 7.069 \times 10^{-4} \times 400$

Step 5 – multiply step by step: $1000 \times 7.069 \times 10^{-4} = 0.7069$

$F = 0.7069 \times 400$

Step 6 – evaluate: $F = 282.7$ N

Final Answer: $F = 282.7$ N $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q29

Q30.

Solution

Concept – rational method for peak runoff: $Q = \dfrac{C\,i\,A}{3.6}$, with C dimensionless, i in mm/hr, A in km^2 and Q in m^3/s.

Step 1 – list the data: $C = 0.50$, $i = 36$ mm/hr, $A = 3$ km^2.

Step 2 – form the numerator $C\,i\,A$: $0.50 \times 36 \times 3$

Step 3 – multiply the first two factors: $0.50 \times 36 = 18$

Step 4 – multiply by the area: $18 \times 3 = 54$

Step 5 – divide by 3.6: $Q = \dfrac{54}{3.6}$

Step 6 – evaluate: $Q = 15\ \text{m}^3/\text{s}$

Final Answer: $Q = 15\ \text{m}^3/\text{s} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q30

Q31.

Solution

Concept – volume represented by a unit hydrograph: A unit hydrograph corresponds to 1 cm of direct runoff over the catchment, so its volume is (depth) $\times$ (area).

Step 1 – convert the runoff depth: $1\ \text{cm} = 0.01\ \text{m}$.

Step 2 – convert the catchment area: $A = 100\ \text{km}^2 = 100 \times 10^6\ \text{m}^2 = 1 \times 10^8\ \text{m}^2$

Step 3 – multiply depth by area: Volume $= 0.01 \times 1 \times 10^8$

Step 4 – evaluate: Volume $= 1 \times 10^6\ \text{m}^3$

Final Answer: Volume $= 1 \times 10^6\ \text{m}^3 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q31

Q32.

Solution

Concept – delta from duty and base period: $\Delta = \dfrac{8.64\,B}{D}$, giving Δ in metres when B is in days and D in ha/cumec.

Step 1 – list the data: $B = 90$ days, $D = 864$ ha/cumec.

Step 2 – form the numerator: $8.64 \times B = 8.64 \times 90 = 777.6$

Step 3 – divide by the duty: $\Delta = \dfrac{777.6}{864}$

Step 4 – evaluate in metres: $\Delta = 0.90\ \text{m}$

Step 5 – convert to centimetres: $\Delta = 0.90 \times 100 = 90\ \text{cm}$

Final Answer: $\Delta = 90\ \text{cm} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q32

Q33.

Solution

Concept – discharge required from area and duty: Duty D is the area (in hectares) that a unit discharge (1 cumec) can irrigate, so $Q = \frac{A}{D}$.

Step 1 – list the data: $A = 100$ ha, $D = 800$ ha/cumec.

Step 2 – substitute: $Q = \frac{100}{800}$

Step 3 – evaluate: $Q = 0.125\ \text{m}^3/\text{s}$

Step 4 – interpret: A continuous supply of 0.125 cumec is needed to irrigate the 100-hectare field.

Final Answer: $Q = 0.125\ \text{m}^3/\text{s} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept – hydrologic risk over a design life: $R = 1 - \left(1 - \frac{1}{T}\right)^n$, where T is the return period and n the design life in years.

Step 1 – list the data: $T = 10$ years, $n = 2$ years.

Step 2 – compute the annual non-exceedance probability: $1-\frac{1}{T} = 1-\frac{1}{10} = 0.90$

Step 3 – raise to the power n: $(0.90)^2 = 0.81$

Step 4 – subtract from 1: $R = 1 - 0.81$

Step 5 – evaluate: $R = 0.19$

Final Answer: $R = 0.19 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept – BOD exerted after time t (base-e form): $\text{BOD}_t = L_0\left(1 - e^{-kt}\right)$, with L_0 the ultimate BOD.

Step 1 – list the data: $L_0 = 250$ mg/L, $k = 0.23\ \text{day}^{-1}$, $t = 3$ days.

Step 2 – form the exponent: $k\,t = 0.23 \times 3 = 0.69$

Step 3 – evaluate the exponential: $e^{-0.69} = 0.5016$

Step 4 – form the bracket: $1 - 0.5016 = 0.4984$

Step 5 – multiply by L_0: $\text{BOD}_3 = 250 \times 0.4984$

Step 6 – evaluate: $\text{BOD}_3 = 124.6 \approx 125$ mg/L

Final Answer: $\text{BOD}_3 \approx 125$ mg/L $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

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

Step 1 – list the data: $V = 800$ m^3, $Q = 4000$ m^3/day.

Step 2 – divide to get the time in days: $t_d = \dfrac{800}{4000} = 0.2$ day

Step 3 – convert to hours: $t_d = 0.2 \times 24$

Step 4 – evaluate: $t_d = 4.8$ hours

Final Answer: $t_d = 4.8$ hours $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept – average daily water demand: Demand $=$ population $\times$ per-capita demand.

Step 1 – list the data: Population $= 1{,}00{,}000$; per-capita demand $= 150$ litres/day.

Step 2 – multiply to get litres per day: $Q = 1{,}00{,}000 \times 150 = 1.5 \times 10^7$ litres/day

Step 3 – convert litres to cubic metres (1000 L = 1 m^3): $Q = \dfrac{1.5 \times 10^7}{1000}$

Step 4 – evaluate: $Q = 15{,}000$ m^3/day

Final Answer: $Q = 15{,}000$ m^3/day $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q37

Q38.

Solution

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

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

Step 4 – interpret: 4.5 mg/L of chlorine was consumed by the impurities before a free residual was left.

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

Answer: (B) Go Back to Q38

Q39.

Solution

Concept – volume of solid waste from mass and density: $V = \dfrac{\text{mass}}{\text{density}}$.

Step 1 – convert the mass to kilograms: 300 tonnes $= 300 \times 1000 = 3{,}00{,}000$ kg/day

Step 2 – list the density: $\rho = 500$ kg/m^3.

Step 3 – divide mass by density: $V = \dfrac{3{,}00{,}000}{500}$

Step 4 – evaluate: $V = 600$ m^3/day

Final Answer: $V = 600$ m^3/day $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q39

Q40.

Solution

Concept – superelevation plus friction to balance a horizontal curve: $e + f = \dfrac{V^2}{127\,R}$, with V in km/h and R in metres.

Step 1 – list the data: $V = 72$ km/h, $R = 200$ m.

Step 2 – square the speed: $V^2 = 72^2 = 5184$

Step 3 – compute the denominator: $127 \times R = 127 \times 200 = 25400$

Step 4 – divide: $e + f = \dfrac{5184}{25400}$

Step 5 – evaluate: $e + f = 0.204 \approx 0.20$

Final Answer: $e + f \approx 0.20 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q40

Q41.

Solution

Concept – stopping sight distance on a level road: $\text{SSD} = v\,t_r + \dfrac{v^2}{2\,g\,f}$, where v is the speed in m/s, t_r the reaction time and f the friction coefficient.

Step 1 – convert the speed to m/s: $v = 36\text{ km/h} = 36 \times \dfrac{5}{18} = 10\text{ m/s}$

Step 2 – compute the reaction (lag) distance: $v\,t_r = 10 \times 2.5 = 25\text{ m}$

Step 3 – compute the braking distance denominator: $2\,g\,f = 2 \times 9.81 \times 0.35 = 6.867$

Step 4 – compute the braking distance: $\dfrac{v^2}{2gf} = \dfrac{10^2}{6.867} = \dfrac{100}{6.867} = 14.56\text{ m}$

Step 5 – add the two parts: $\text{SSD} = 25 + 14.56$

Step 6 – evaluate: $\text{SSD} = 39.56 \approx 39.6\text{ m}$

Final Answer: $\text{SSD} \approx 39.6\text{ m} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q41

Q42.

Solution

Concept – speed at maximum flow in Greenshields' model: In the linear speed–density model the flow is maximum at one half of the free-flow speed, $V_{opt} = \dfrac{V_f}{2}$.

Step 1 – list the data: Free-flow speed $V_f = 80\text{ km/h}$.

Step 2 – apply the half-speed rule: $V_{opt} = \dfrac{80}{2}$

Step 3 – evaluate: $V_{opt} = 40\text{ km/h}$

Step 4 – reasoning: The parabolic flow–speed relation peaks midway between zero speed (jam) and free-flow speed, hence half the free-flow speed.

Final Answer: $V_{opt} = 40\text{ km/h} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q42

Q43.

Solution

Concept – reduced level by the height-of-instrument method: $\mathrm{HI} = \mathrm{RL}_{BM} + \mathrm{BS}$ and $\mathrm{RL}_P = \mathrm{HI} - \mathrm{FS}$.

Step 1 – compute the height of instrument: $\mathrm{HI} = 150.000 + 2.500$

$\mathrm{HI} = 152.500$ m

Step 2 – subtract the fore sight to get the RL of P: $\mathrm{RL}_P = 152.500 - 1.200$

Step 3 – evaluate: $\mathrm{RL}_P = 151.300$ m

Step 4 – interpret: The fore sight (1.200) is smaller than the back sight (2.500), so P is higher than the benchmark, and indeed $151.300 > 150.000$. Consistent.

Final Answer: $\mathrm{RL}_P = 151.300 \text{ m} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q43

Q44.

Solution

Concept – sum of interior angles of a closed traverse: For a closed polygon of n sides, $\sum$ interior angles $= (2n-4) \times 90°$.

Step 1 – count the sides: The traverse is a hexagon, so $n = 6$.

Step 2 – form $(2n-4)$: $2(6) - 4 = 12 - 4 = 8$

Step 3 – multiply by $90°$: $\sum = 8 \times 90°$

Step 4 – evaluate: $\sum = 720°$

Step 5 – cross-check: The formula also reads $(n-2) \times 180° = 4 \times 180° = 720°$, which agrees.

Final Answer: $\sum = 720° \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q44

Q45.

Solution

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

Step 1 – list the data: $R = 200$ m, $\Delta = 90°$.

Step 2 – halve the deflection angle: $\dfrac{\Delta}{2} = \dfrac{90°}{2} = 45°$

Step 3 – evaluate the tangent: $\tan 45^\circ = 1$

Step 4 – multiply by the radius: $T = 200 \times 1$

Step 5 – evaluate: $T = 200.0$ m

Final Answer: $T = 200.0$ m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q45

Q46.

Solution

Concept – converting a whole-circle bearing (WCB) to a reduced (quadrantal) bearing: A WCB between 180° and 270° lies in the third (south-west) quadrant, and the reduced bearing is WCB $- 180^\circ$, measured from south towards west.

Step 1 – locate the quadrant: WCB $= 210^\circ$ lies between 180° and 270°, so it is in the SW quadrant.

Step 2 – compute the reduced angle: $210^\circ - 180^\circ = 30^\circ$

Step 3 – attach the quadrant letters: Measured from south towards west, the reduced bearing is S 30° W.

Why the other options are wrong:

- B, N30°E: is the reduced bearing of a WCB of 30° (first quadrant), not 210°.
- C, S60°W: would correspond to a WCB of 240°.
- D, N60°W: would correspond to a WCB of 300°.

Final Answer: reduced bearing $=$ S 30° W $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q46

Answer Key

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