GATE Civil Engineering

Sample Paper – 2

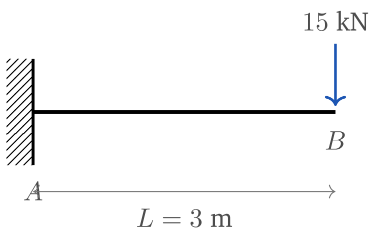
Duration: 128 Minutes **Maximum Marks: 72**

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 of length 3 m is fixed at A and carries a single vertical point load of 15 kN at its free end B, as shown. The magnitude of the fixing (reaction) moment developed at the support A is: **[1 mark]**



(A) 45 kN·m

(B) 15 kN·m

(C) 30 kN·m

(D) 22.5 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 of steel as $E = 200$ GPa, the axial elongation of the rod is: **[1 mark]**

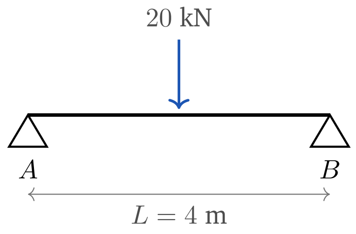
(A) 0.5 mm

(B) 1.0 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 20 kN at its midspan, as shown. The maximum bending moment in the beam is: **[1 mark]**



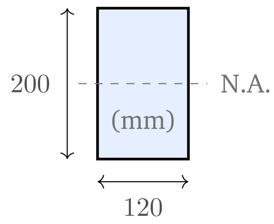
(A) 80 kN·m

(B) 40 kN·m

(C) 10 kN·m

(D) 20 kN·m

Q4. A beam has the solid rectangular cross-section shown below, of width 120 mm and depth 200 mm. The moment of inertia of this section about its horizontal centroidal axis is: **[1 mark]**



(A) 8×10^7 mm^4

(B) 1.2×10^8 mm^4

(C) 4×10^7 mm^4

(D) 2.4×10^8 mm^4

Q5. For a beam of solid *circular* cross-section carrying a transverse shear force, the ratio of the maximum shear stress (at the neutral axis) to the average shear stress over the section is: **[1 mark]**

(A) $\frac{3}{2}$

(B) 2

(C) $\frac{4}{3}$

(D) 1

Q6. A solid circular shaft of length L, polar moment of inertia J and shear modulus G carries a torque T. The total angle of twist between the two ends of the shaft is: **[1 mark]**

(A) $\frac{TJ}{GL}$

(B) $\frac{TL}{GA}$

(C) $\frac{TL}{GJ}$

(D) $\frac{GJ}{TL}$

Q7. A cantilever beam of length L and flexural rigidity EI carries a uniformly distributed load of intensity w over its entire length. The maximum vertical deflection (at the free end) of the cantilever is: **[1 mark]**

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

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

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

(D) $\dfrac{wL^4}{8EI}$

Q8. A straight column is fixed (restrained against rotation and translation) at its base and completely free at its top. For use in the Euler buckling formula, the effective length of this column is: **[1 mark]**

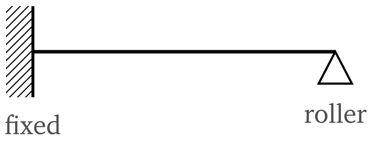
(A) $2.0\,L$

(B) $1.0\,L$

(C) $0.5\,L$

(D) $0.707\,L$

Q9. A propped cantilever beam is fixed at one end and simply supported (on a roller) at the other end, as shown. The degree of static indeterminacy of this beam is: **[1 mark]**



(A) 1

(B) 0

(C) 2

(D) 3

Q10. For a simply supported beam AB of span L, consider the influence line for the bending moment at the midspan section C. The maximum ordinate of this influence line (which occurs when the unit load stands at midspan) is: **[1 mark]**

(A) $\dfrac{L}{2}$

(B) L

(C) $\frac{L}{8}$

(D) $\frac{L}{4}$

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

(A) 1.0

(B) 0.25

(C) 0.75

(D) 0.5

Q12. In the limit state design of reinforced concrete to IS 456:2000, the maximum compressive strain permitted in concrete at the outermost compression fibre of a section in flexure at the ultimate limit state is: **[1 mark]**

(A) 0.0020

(B) 0.0038

(C) 0.0035

(D) 0.0050

Q13. As per the limit state method of IS 800:2007 for steel structures, the partial safety factor applied to the resistance governed by *ultimate stress* (for example, net-section rupture of a tension member), γ_{m1}, is: **[1 mark]**

(A) 1.10

(B) 1.25

(C) 1.15

(D) 1.50

Q14. In a PERT network, an activity has an optimistic time $t_o = 6$ days and a pessimistic time $t_p = 24$ days. The standard deviation of the duration of this activity is: **[1 mark]**

(A) 1 day

(B) 2 days

(C) 3 days

(D) 4 days

Geotechnical Engineering

Q15. A soil has a porosity of 0.50. The corresponding void ratio of the soil is: **[1 mark]**

(A) 1.0

(B) 0.5

(C) 2.0

(D) 0.33

Q16. A fine-grained soil has a natural water content of 30%, a plastic limit of 20% and a liquid limit of 40%. The liquidity index of the soil is: **[1 mark]**

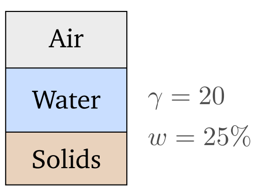
(A) 0.50

(B) 1.00

(C) 0.25

(D) 0.75

Q17. A soil sample has a bulk (moist) unit weight of 20 kN/m^3 at a water content of 25%. Using the three-phase block shown, the dry unit weight of the soil is: **[1 mark]**



(A) $25.0\ \text{kN/m}^3$

(B) $16.0\ \text{kN/m}^3$

(C) $20.0\ \text{kN/m}^3$

(D) $15.0\ \text{kN/m}^3$

Q18. A homogeneous soil deposit has its water table at the ground surface. The pore water pressure at a depth of 4 m below the surface is nearest to: **[1 mark]**

(A) $78.48\ \text{kN/m}^2$

(B) $80.00\ \text{kN/m}^2$

(C) $40.00\ \text{kN/m}^2$

(D) $39.24\ \text{kN/m}^2$

Q19. In a constant-head permeability set-up, water flows through a soil sample of length 200 mm subjected to a head difference of 50 mm across its ends. The hydraulic gradient acting on the sample is: **[1 mark]**

(A) 0.50

(B) 0.25

(C) 4.00

(D) 2.50

Q20. A sand deposit has a maximum void ratio $e_{\max} = 0.80$, a minimum void ratio $e_{\min} = 0.40$ and an in-situ void ratio $e = 0.60$. The relative density (density index) of the sand is: **[1 mark]**

(A) 25%

(B) 75%

(C) 50%

(D) 40%

Geotechnical Engineering (continued)

Q21. A saturated normally-consolidated clay layer 4 m thick has a compression index $C_c = 0.30$ and an initial void ratio $e_0 = 0.80$. Under a wide loading, the effective vertical stress at mid-depth of the layer increases from 100 kPa to 200 kPa. The primary consolidation settlement of the layer is nearest to: **[2 marks]**

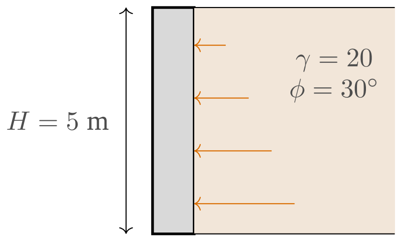
(A) 100 mm

(B) 300 mm

(C) 150 mm

(D) 200 mm

Q22. A vertical retaining wall 5 m high retains a dry cohesionless backfill with a horizontal top surface, unit weight 20 kN/m^3 and friction angle $\phi = 30°$, as shown. Using Rankine's theory, the total *passive* earth thrust per metre run of the wall is: **[2 marks]**



(A) 250 kN/m

(B) 375 kN/m

(C) 500 kN/m

(D) 750 kN/m

Q23. For a shallow footing, the net ultimate bearing capacity of the supporting soil is 270 kPa. Adopting a factor of safety of 3 against a shear (bearing-capacity) failure, the net safe bearing capacity of the footing is: **[2 marks]**

(A) 90 kPa

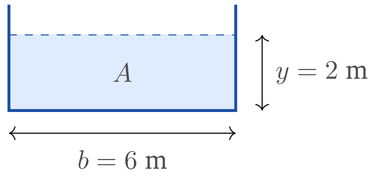
(B) 810 kPa

(C) 135 kPa

(D) 270 kPa

Water Resources Engineering

Q24. A rectangular channel of width 6 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) 2.00 m

(B) 1.20 m

(C) 0.83 m

(D) 1.50 m

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

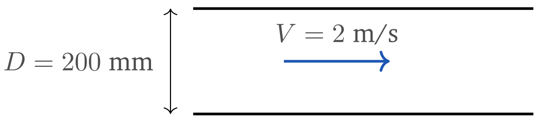
(A) 1.5 m

(B) 3.0 m

(C) 1.0 m

(D) 2.0 m

Q26. Water flows steadily through a pipe of diameter 200 mm at a mean velocity of 2 m/s, as shown. The volumetric discharge carried by the pipe is: **[2 marks]**



(A) 125.7 L/s

(B) 62.8 L/s

(C) 31.4 L/s

(D) 251.3 L/s

Q27. Water flows in a wide open channel. At a section the hydraulic radius is 1 m, the bed slope is 0.0016 and Manning's roughness coefficient is $n = 0.02$. Using Manning's formula, the mean velocity of flow is: **[2 marks]**

(A) 1.0 m/s

(B) 4.0 m/s

(C) 2.0 m/s

(D) 0.5 m/s

Q28. Water flows in a rectangular channel at a mean velocity of 3 m/s and a depth of 1 m. The Froude number of the flow is nearest to: **[2 marks]**

(A) 3.00

(B) 0.96

(C) 1.00

(D) 9.81

Q29. Water discharges to the atmosphere through a small sharp-edged orifice in the side of a large tank, under a constant head of 5 m measured from the centre of the orifice. Neglecting all losses (coefficient of velocity = 1), the theoretical velocity of the jet at the orifice is nearest to: **[2 marks]**

(A) 9.9 m/s

(B) 98.1 m/s

(C) 5.0 m/s

(D) 49.05 m/s

Q30. A storm produces 5 cm of effective (direct-runoff) rainfall uniformly over a catchment of area 100 km^2. The total volume of direct runoff generated is: **[2 marks]**

(A) 5×10^6 m^3

(B) 5×10^5 m^3

(C) 5×10^7 m^3

(D) 5×10^4 m^3

Q31. Over a small catchment, a storm of total rainfall depth 8 cm lasting 4 hours produces a direct runoff of 5 cm. Assuming a uniform infiltration loss, the ϕ-index (average infiltration rate) for the storm is: **[2 marks]**

(A) 1.25 cm/hr

(B) 0.75 cm/hr

(C) 2.00 cm/hr

(D) 0.50 cm/hr

Q32. In a field application of irrigation water, 100 units of water are delivered to the field, of which 75 units are stored within the crop root zone (the remainder is lost to deep percolation and runoff). The water application efficiency of the irrigation is: **[2 marks]**

(A) 25%

(B) 133%

(C) 75%

(D) 50%

Q33. A canal is required to irrigate a culturable command area of 8640 hectares for a crop whose duty at the head of the canal is 864 hectares per cumec. The discharge that the canal must carry is: **[2 marks]**

(A) 10 m^3/s

(B) 100 m^3/s

(C) 1 m^3/s

(D) 5 m^3/s

Q34. At a gauging site, the probability that a certain flood magnitude is equalled or exceeded in any one year is 0.02. The return period (recurrence interval) of this flood magnitude is: **[2 marks]**

(A) 2 years

(B) 20 years

(C) 50 years

(D) 0.5 years

Environmental Engineering

Q35. A sedimentation tank of capacity 200 m^3 treats a continuous flow of 800 m^3/day. The theoretical detention (retention) time of water in the tank is: **[2 marks]**

(A) 4 hours

(B) 6 hours

(C) 3 hours

(D) 12 hours

Q36. In the disinfection of a water supply, chlorine is applied at a dose of 3.0 mg/L. After the contact period, the free chlorine residual measured is 0.5 mg/L. The chlorine demand of the water is: **[2 marks]**

(A) 3.5 mg/L

(B) 0.5 mg/L

(C) 2.5 mg/L

(D) 3.0 mg/L

Q37. A town has a population of $100{,}000$ with an average per-capita water demand of 200 litres per day. If 80% of the water supplied returns as sewage, the average daily dry-weather sewage flow from the town is: **[2 marks]**

(A) 20000 m^3/day

(B) 16000 m^3/day

(C) 1600 m^3/day

(D) 160000 m^3/day

Q38. At a place the environmental lapse rate is very nearly equal to the dry adiabatic lapse rate, so the atmosphere is in a neutral condition. With respect to the dispersion of smoke released from a tall stack, the plume then takes the characteristic shape known as: **[2 marks]**

(A) looping

(B) coning

(C) fanning

(D) fumigation

Q39. A city has a population of 200,000 and the average rate of municipal solid waste generation is 0.5 kg per capita per day. The total mass of solid waste generated by the city each day is: **[2 marks]**

(A) 400 tonnes/day

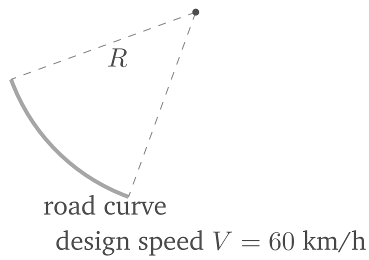
(B) 50 tonnes/day

(C) 200 tonnes/day

(D) 100 tonnes/day

Transportation & Geomatics Engineering

Q40. A horizontal highway curve is to be designed for a speed of 60 km/h. The combined value of superelevation and side-friction factor available is $e + f = 0.15$. Using $e + f = V^2/(127R)$, the minimum radius of the curve is nearest to: **[2 marks]**



(A) 100 m

(B) 189 m

(C) 250 m

(D) 300 m

Q41. A vehicle travels at a speed of 90 km/h on a level highway. The driver's total reaction (perception–brake) time is 2.5 s. The distance covered by the vehicle during the reaction time alone (the lag distance) is: **[2 marks]**

(A) 25 m

(B) 90 m

(C) 100 m

(D) 62.5 m

Q42. A traffic stream is described by Greenshields' linear speed–density model with a free-flow speed of 64 km/h. The speed of the stream at which the flow (volume) is a maximum is: **[2 marks]**

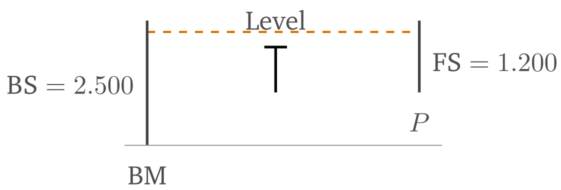
(A) 32 km/h

(B) 64 km/h

(C) 16 km/h

(D) 128 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]**



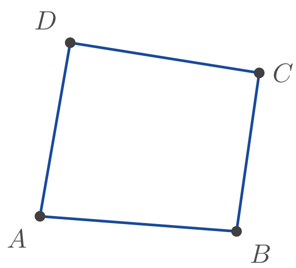
(A) 148.700 m

(B) 153.700 m

(C) 151.300 m

(D) 146.300 m

Q44. A closed traverse has the shape of a four-sided polygon (quadrilateral) $ABCD$, as shown. For the traverse to close correctly, the theoretical sum of its *exterior* angles should be: **[2 marks]**



(A) $1080°$

(B) $720°$

(C) $360°$

(D) $540°$

Q45. A simple circular curve of radius 200 m has a deflection (intersection) angle of $60°$. The tangent length of the curve (from the point of curve to the point of intersection) is nearest to: **[2 marks]**

(A) 200 m

(B) 100 m

(C) 173.2 m

(D) 115.47 m

Q46. A tacheometer with a multiplying (stadia) constant of 100 and an additive constant of 0 is sighted, with the line of sight horizontal and the staff vertical. The upper and lower stadia hair readings on the staff are 1.500 m and 1.100 m respectively. The horizontal distance from the instrument to the staff is: **[2 marks]**

(A) 260 m

(B) 130 m

(C) 40 m

(D) 400 m

Detailed Solutions

Q1.

Solution

Concept – fixing moment of a cantilever under an end load: For a cantilever the support moment equals the load times its distance from the fixed end.

Step 1 – list the data: Length $L = 3$ m, end load $W = 15$ kN.

Step 2 – take moments about the fixed end A: $M_A = W \times L$

Step 3 – substitute the values: $M_A = 15 \times 3$

Step 4 – evaluate: $M_A = 45$ kN·m

Final Answer: $M_A = 45$ kN·m $\Rightarrow \boxed{\text{A}}$

Answer: (A) 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 – write each quantity in consistent units: $P = 50$ kN $= 50000$ N, $L = 2$ m $= 2000$ mm, $A = 500$ mm^2, $E = 200$ GPa $= 200000$ N/mm^2.

Step 2 – form the numerator: $PL = 50000 \times 2000 = 1.0 \times 10^8$

Step 3 – form the denominator: $AE = 500 \times 200000 = 1.0 \times 10^8$

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

$\delta = 1.0$ mm

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

Answer: (B) Go Back to Q2

Q3.

Solution

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

Step 1 – list the data: $W = 20$ kN, $L = 4$ m.

Step 2 – substitute into the formula: $M_{\max} = \dfrac{20 \times 4}{4}$

Step 3 – simplify: $M_{\max} = \dfrac{80}{4}$

$M_{\max} = 20$ kN·m

Step 4 – sanity check: Each reaction is $W/2 = 10$ kN; the midspan moment $= 10 \times 2 = 20$ kN·m, which agrees.

Final Answer: $M_{\max} = 20$ kN·m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q3

Q4.

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.

Step 1 – list the data: $b = 120$ mm, $d = 200$ mm.

Step 2 – evaluate d^3: $200^3 = 8{,}000{,}000$

Step 3 – multiply by the width: $b\,d^3 = 120 \times 8{,}000{,}000 = 960{,}000{,}000$

Step 4 – divide by 12**:** $I = \dfrac{960{,}000{,}000}{12}$

$I = 80{,}000{,}000$ mm^4

$I = 8 \times 10^7$ mm^4

Final Answer: $I = 8 \times 10^7$ mm$^4 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q4

Q5.

Solution

Concept – shape factor for shear in a circular section: The transverse shear stress over a solid circular section varies parabolically and peaks at the neutral axis, where $\tau_{\max} = \dfrac{4}{3}\tau_{\text{avg}}$.

Step 1 – recall the average shear stress: $\tau_{\text{avg}} = \dfrac{V}{A}$, the mean over the whole area.

Step 2 – recall the peak value for a circle: For a solid circular cross-section the maximum shear stress at the neutral axis is $\tau_{\max} = \dfrac{4}{3}\dfrac{V}{A}$.

Step 3 – form the ratio: $\dfrac{\tau_{\max}}{\tau_{\text{avg}}} = \dfrac{4}{3}$

Why the other options are wrong:

- A, $3/2$: is the ratio for a **rectangular** section, not a circular one.
- B, 2: is the ratio for a thin-walled **circular tube**.
- D, 1: would mean uniform shear, which is not the case for a solid section.

Final Answer: $\dfrac{\tau_{\max}}{\tau_{\text{avg}}} = \dfrac{4}{3} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept – torsion equation for a circular shaft: $\dfrac{T}{J} = \dfrac{G\,\theta}{L}$, which rearranges to give the angle of twist.

Step 1 – start from the torsion relation: $\dfrac{T}{J} = \dfrac{G\,\theta}{L}$

Step 2 – isolate θ: $\theta = \dfrac{T\,L}{G\,J}$

Step 3 – check the dependence: The twist grows with torque T and length L, and falls with the torsional rigidity GJ, matching option C.

Why the other options are wrong:

- A, $TJ/(GL)$: puts J and L on the wrong sides; the units are not those of an angle.
- B, $TL/(GA)$: uses the area A in place of the polar moment J, which governs torsion.
- D, $GJ/(TL)$: is the reciprocal (the torsional stiffness per unit twist), not the twist itself.

Final Answer: $\theta = \dfrac{TL}{GJ} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept – free-end deflection of a cantilever under a full-span UDL: For a cantilever of length L carrying a uniform load w over its whole span, the maximum deflection occurs at the free end.

Step 1 – recall the standard result: $\delta_{\max} = \dfrac{wL^4}{8EI}$

Step 2 – confirm the dependence: The deflection grows with the fourth power of the span L^4 (a distributed-load signature) and falls with EI.

Why the other options are wrong:

- A, $WL^3/3EI$: is the free-end deflection of a cantilever under a **point** load at the tip, not a UDL.
- B, $5wL^4/384EI$: is the midspan deflection of a **simply supported** beam under a UDL.
- C, $wL^4/384EI$: is the midspan deflection of a **fixed–fixed** beam under a UDL.

Final Answer: $\delta_{\max} = \dfrac{wL^4}{8EI} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

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

Step 1 – identify the end conditions: The column is **fixed at the base and free at the top** (a flagpole-type column).

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:

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

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

Answer: (A) Go Back to Q8

Q9.

Solution

Concept – static indeterminacy of a beam: $D_s = R - 3$, where R is the number of independent support reaction components and 3 is the number of equilibrium equations available for a planar beam.

Step 1 – count the reactions: A fixed end supplies 3 reactions (vertical, horizontal, moment); a roller supplies 1 (vertical). So $R = 3 + 1 = 4$.

Step 2 – subtract the equilibrium equations: $D_s = R - 3 = 4 - 3$

Step 3 – evaluate: $D_s = 1$

Step 4 – interpret: The beam has one more reaction than statics can solve, so it is indeterminate to the first degree.

Why the other options are wrong:

- B, 0: would describe a just-determinate beam, such as a simple span on one hinge and one roller.
- C, 2 and D, 3: over-count the redundancy of this propped cantilever.

Final Answer: $D_s = 1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept – influence line for the bending moment at midspan of a simple beam: The influence-line ordinate for the moment at a section C is the moment at C produced by a unit moving load; for midspan it is a triangle peaking under the load at C.

Step 1 – place the unit load at midspan: With the section and the load both at midspan ($a = b = L/2$), the moment influence-line ordinate is $\dfrac{a\,b}{L}$.

Step 2 – substitute $a = b = L/2$**:** $\dfrac{a\,b}{L} = \dfrac{(L/2)(L/2)}{L}$

Step 3 – simplify: $= \dfrac{L^2/4}{L} = \dfrac{L}{4}$

Step 4 – identify the maximum: This peak ordinate $L/4$ is the largest value on the triangular influence line.

Why the other options are wrong:

- A, $L/2$ and B, L: overstate the peak; the correct apex of the midspan-moment influence line is $L/4$.
- C, $L/8$: is half the correct peak.

Final Answer: maximum ordinate $= \dfrac{L}{4} \Rightarrow \boxed{\text{D}}$

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

Q11.

Solution

Concept – carry-over factor in moment distribution: The carry-over factor is the ratio of the moment induced at the fixed far end to the moment applied at the near end.

Step 1 – apply a moment at the near end: Rotating the near end of a prismatic member (with the far end held fixed) develops a moment there equal to $\dfrac{4EI}{L}\theta$.

Step 2 – find the moment induced at the far end: The moment carried over to the fixed far end is $\dfrac{2EI}{L}\theta$.

Step 3 – form the ratio: $\text{COF} = \dfrac{2EI\theta/L}{4EI\theta/L} = \dfrac{2}{4}$

$\text{COF} = 0.5$

Why the other options are wrong:

- A, 1.0: would mean the full moment is transmitted, which is not the case for a prismatic member.
- B, 0.25 and C, 0.75: do not match the $2:4$ stiffness ratio that governs a prismatic member.

Final Answer: $\text{COF} = 0.5 \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q11**

Q12.

Solution

Concept – limiting strain in concrete in limit-state flexure: IS 456:2000 fixes the maximum compressive strain in concrete at the extreme fibre in bending at the ultimate limit state as a code constant, independent of the steel grade.

Step 1 – recall the code value: $\varepsilon_{cu} = 0.0035$

Step 2 – distinguish it from the strain used elsewhere: The strain of 0.002 is the strain at which concrete reaches its design compressive stress in the parabolic–rectangular stress block; the *extreme-fibre failure* strain in flexure is 0.0035.

Why the other options are wrong:

- A, 0.0020: is the strain at the onset of the constant-stress plateau, not the failure strain.
- B, 0.0038 and D, 0.0050: are not the code-specified limiting flexural strain.

Final Answer: $\varepsilon_{cu} = 0.0035 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q12

Q13.

Solution

Concept – partial safety factors for steel in IS 800:2007: Yielding of the gross section uses γ_{m0}, while resistance governed by the ultimate stress (rupture) uses γ_{m1}.

Step 1 – identify the failure mode: Net-section rupture of a tension member is governed by the *ultimate* tensile stress, so the relevant factor is γ_{m1}.

Step 2 – recall its value: $\gamma_{m1} = 1.25$

Why the other options are wrong:

- A, 1.10: is γ_{m0}, used for resistance governed by **yielding**, not rupture.
- C, 1.15: is the partial safety factor for reinforcing steel in RCC (IS 456), not structural steel.
- D, 1.50: is the partial safety factor for concrete in RCC.

Final Answer: $\gamma_{m1} = 1.25 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept – PERT standard deviation of an activity: $\sigma = \dfrac{t_p - t_o}{6}$, the spread of the beta distribution between the optimistic and pessimistic estimates.

Step 1 – list the two extreme times: $t_o = 6$ days, $t_p = 24$ days.

Step 2 – form the range in the numerator: $t_p - t_o = 24 - 6 = 18$

Step 3 – divide by 6: $\sigma = \frac{18}{6}$

$\sigma = 3$ days

Step 4 – note the variance: The variance is $\sigma^2 = 3^2 = 9$ days^2, which is consistent.

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

Answer: (C) Go Back to Q14

Q15.

Solution

Concept – void ratio from porosity: $e = \frac{n}{1-n}$, since n is voids per total volume and e is voids per solids.

Step 1 – list the data: $n = 0.50$.

Step 2 – form the denominator: $1 - n = 1 - 0.50 = 0.50$

Step 3 – divide: $e = \frac{0.50}{0.50}$

$e = 1.0$

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

Answer: (A) Go Back to Q15

Q16.

Solution

Concept – liquidity index measures where the water content sits in the plastic range: $I_L = \frac{w - \text{PL}}{\text{LL} - \text{PL}} = \frac{w - \text{PL}}{I_p}$.

Step 1 – list the data: $w = 30\%$, PL $= 20\%$, LL $= 40\%$.

Step 2 – compute the plasticity index (denominator): $I_p = \text{LL} - \text{PL} = 40 - 20 = 20$

Step 3 – compute the numerator: $w - \text{PL} = 30 - 20 = 10$

Step 4 – divide: $I_L = \frac{10}{20}$

$I_L = 0.50$

Final Answer: $I_L = 0.50 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

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

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

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

Step 3 – divide the bulk unit weight: $\gamma_d = \dfrac{20}{1.25}$

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

Why the other options are wrong:

- C, 20: is the **bulk** unit weight, which already includes the water.
- A, 25: wrongly *adds* rather than removes the water contribution.

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

Answer: (B) Go Back to Q17

Q18.

Solution

Concept – hydrostatic pore water pressure: $u = \gamma_w\, z_w$, where z_w is the depth of the point below the water table.

Step 1 – locate the water table: It is at the ground surface, so the depth below the water table equals the depth below the surface, $z_w = 4$ m.

Step 2 – substitute into $u = \gamma_w z_w$: $u = 9.81 \times 4$

Step 3 – evaluate: $u = 39.24\ \text{kN/m}^2$

Why the other options are wrong:

- A, 78.48: uses $2\gamma_w$, doubling the correct pressure.
- C, 40: rounds γ_w to 10 instead of using 9.81.

Final Answer: $u = 39.24\ \text{kN/m}^2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept – hydraulic gradient: $i = \dfrac{\Delta h}{L}$, the head loss per unit length of flow path (a dimensionless ratio).

Step 1 – list the data (same units): Head difference $\Delta h = 50$ mm, flow length $L = 200$ mm.

Step 2 – form the ratio: $i = \dfrac{50}{200}$

Step 3 – evaluate: $i = 0.25$

Step 4 – note it is dimensionless: Both quantities are lengths, so their ratio has no units.

Final Answer: $i = 0.25 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q19

Q20.

Solution

Concept – relative density (density index) of a sand: $I_D = \dfrac{e_{\max} - e}{e_{\max} - e_{\min}}$.

Step 1 – list the data: $e_{\max} = 0.80$, $e_{\min} = 0.40$, $e = 0.60$.

Step 2 – compute the numerator: $e_{\max} - e = 0.80 - 0.60 = 0.20$

Step 3 – compute the denominator: $e_{\max} - e_{\min} = 0.80 - 0.40 = 0.40$

Step 4 – divide: $I_D = \dfrac{0.20}{0.40}$

$I_D = 0.50 = 50\%$

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

Answer: (C) Go Back to Q20

Q21.

Solution

Concept – one-dimensional primary consolidation settlement: $S_c = \dfrac{C_c H}{1 + e_0} \log_{10} \dfrac{\sigma'_0 + \Delta\sigma'}{\sigma'_0}$ for a normally-consolidated clay.

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

Step 2 – compute the leading coefficient: $\dfrac{C_c H}{1 + e_0} = \dfrac{0.30 \times 4}{1 + 0.80} = \dfrac{1.20}{1.80}$

$= 0.6667$ m

Step 3 – compute the stress ratio and its logarithm: $\frac{200}{100} = 2$, and $\log_{10} 2 = 0.3010$

Step 4 – multiply the two parts: $S_c = 0.6667 \times 0.3010$

$S_c = 0.2007$ m

Step 5 – convert to millimetres: $S_c = 0.2007 \times 1000 \approx 200$ mm

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

Answer: (D) **Go Back to Q21**

Q22.

Solution

Concept – Rankine passive thrust on a wall with cohesionless backfill: $P_p = \frac{1}{2} K_p \gamma H^2$, with $K_p = \dfrac{1 + \sin\phi}{1 - \sin\phi}$.

Step 1 – compute the passive earth-pressure coefficient: $K_p = \dfrac{1 + \sin 30°}{1 - \sin 30°} = \dfrac{1 + 0.5}{1 - 0.5}$

$K_p = \dfrac{1.5}{0.5} = 3$

Step 2 – evaluate H^2: $H^2 = 5^2 = 25$ m^2

Step 3 – substitute into the thrust formula: $P_p = \frac{1}{2} \times 3 \times 20 \times 25$

Step 4 – simplify step by step: $3 \times 20 = 60$

$P_p = \frac{1}{2} \times 60 \times 25$

$P_p = \frac{1}{2} \times 1500$

$P_p = 750$ kN/m

Final Answer: $P_p = 750$ kN/m $\Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q22**

Q23.

Solution

Concept – factor of safety on bearing capacity: $q_{ns} = \dfrac{q_{nu}}{\text{FOS}}$, where q_{nu} is the net ultimate and q_{ns} the net safe bearing capacity.

Step 1 – list the data: $q_{nu} = 270$ kPa, FOS $= 3$.

Step 2 – divide by the factor of safety: $q_{ns} = \dfrac{270}{3}$

Step 3 – evaluate: $q_{ns} = 90$ kPa

Why the other options are wrong:

- B, 810: *multiplies* by the factor of safety instead of dividing.
- D, 270: is the net ultimate value, with no factor of safety applied.

Final Answer: $q_{ns} = 90$ kPa $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q23

Q24.

Solution

Concept – hydraulic radius of a channel: $R = \dfrac{A}{P}$, the flow area divided by the wetted perimeter.

Step 1 – compute the flow area: $A = b\,y = 6 \times 2 = 12\ \text{m}^2$

Step 2 – compute the wetted perimeter (bed plus two sides): $P = b + 2y = 6 + 2(2) = 6 + 4 = 10$ m

Step 3 – form the ratio: $R = \dfrac{12}{10}$

$R = 1.2$ m

Step 4 – sanity check: The hydraulic radius is smaller than the flow depth of 2 m, as expected for an open channel. Consistent.

Final Answer: $R = 1.2$ m $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q24

Q25.

Solution

Concept – centre of pressure of a surface-piercing vertical plane: For a vertical rectangle with its top edge at the free surface, the centre of pressure lies at two-thirds of the total depth below the surface, $h_{cp} = \frac{2}{3}\,h$.

Step 1 – note the depth of the gate: $h = 3$ m, with the top edge at the water surface.

Step 2 – apply the two-thirds rule: $h_{cp} = \dfrac{2}{3} \times 3$

Step 3 – evaluate: $h_{cp} = 2.0$ m

Step 4 – cross-check with the general formula: $h_{cp} = \bar{h} + \dfrac{I_G}{A\,\bar{h}}$, with $\bar{h} = 1.5$ m, $I_G = \frac{bh^3}{12} = \frac{2\times 27}{12} = 4.5\ \text{m}^4$, $A = 6\ \text{m}^2$: $h_{cp} = 1.5 + \dfrac{4.5}{6\times 1.5} = 1.5 + 0.5 = 2.0$ m. Consistent.

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

Answer: (D) Go Back to Q25

Q26.

Solution

Concept – discharge is area times mean velocity: $Q = AV$, with A the cross-sectional area of the pipe.

Step 1 – convert the diameter and compute the area: $D = 200\ \text{mm} = 0.20\ \text{m}$

$A = \dfrac{\pi}{4}D^2 = \dfrac{\pi}{4}(0.20)^2$

$= \dfrac{\pi}{4} \times 0.04$

$= 0.031416\ \text{m}^2$

Step 2 – multiply by the velocity: $Q = 0.031416 \times 2$

$Q = 0.062832\ \text{m}^3/\text{s}$

Step 3 – convert to litres per second ($1\ \text{m}^3 = 1000$ L): $Q = 0.062832 \times 1000$

$Q = 62.8$ L/s

Final Answer: $Q = 62.8\ \text{L/s} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

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

Step 1 – list the data: $n = 0.02$, $R = 1$ m, $S = 0.0016$.

Step 2 – evaluate $R^{2/3}$: $R^{2/3} = 1^{2/3} = 1$

Step 3 – evaluate $S^{1/2}$: $S^{1/2} = \sqrt{0.0016} = 0.04$

Step 4 – form $1/n$: $\dfrac{1}{n} = \dfrac{1}{0.02} = 50$

Step 5 – multiply the three factors: $V = 50 \times 1 \times 0.04$

$V = 2.0$ m/s

Final Answer: $V = 2.0$ m/s $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q27

Q28.

Solution

Concept – Froude number for open-channel flow: $Fr = \dfrac{V}{\sqrt{g\,y}}$, with y the flow depth for a rectangular channel.

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

Step 2 – compute $g\,y$: $g\,y = 9.81 \times 1 = 9.81$

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

Step 4 – divide the velocity: $Fr = \dfrac{3}{3.132}$

$Fr = 0.958 \approx 0.96$

Step 5 – classify the flow: $Fr < 1$, so the flow is subcritical, which is consistent with the modest velocity and depth.

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

Answer: (B) Go Back to Q28

Q29.

Solution

Concept – Torricelli's theorem for efflux from an orifice: The ideal jet velocity under a head H is $V = \sqrt{2gH}$.

Step 1 – list the data: $H = 5$ m, $g = 9.81$ m/s^2.

Step 2 – form the product $2gH$: $2gH = 2 \times 9.81 \times 5$

$= 98.1$

Step 3 – take the square root: $V = \sqrt{98.1}$

$V = 9.905 \approx 9.9$ m/s

Why the other options are wrong:

- B, 98.1: is the value of $2gH$ before taking the square root.
- C, 5.0: simply repeats the head, ignoring gravity.

Final Answer: $V \approx 9.9$ m/s $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept – runoff volume is depth times catchment area: $V = d \times A$, once the depth and area are in consistent units.

Step 1 – convert the runoff depth to metres: $d = 5 \text{ cm} = 0.05 \text{ m}$

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

Step 3 – multiply: $V = 0.05 \times 1 \times 10^8$

$V = 5 \times 10^6 \text{ m}^3$

Why the other options are wrong:

- B, 5×10^5 and D, 5×10^4: under-count by mishandling the km^2-to-m^2 conversion.
- C, 5×10^7: over-counts by a factor of ten.

Final Answer: $V = 5 \times 10^6 \text{ m}^3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q30

Q31.

Solution

Concept – the ϕ-index is the uniform loss rate that leaves the runoff behind: $\phi = \dfrac{P - R}{t_R}$, where P is the rainfall depth, R the runoff depth and t_R the storm duration.

Step 1 – find the total infiltration (loss) depth: $P - R = 8 - 5 = 3 \text{ cm}$

Step 2 – divide by the storm duration: $\phi = \dfrac{3}{4}$

Step 3 – evaluate: $\phi = 0.75 \text{ cm/hr}$

Step 4 – interpret: Water is lost at 0.75 cm/hr; the rest of the 8 cm rainfall appears as the 5 cm of direct runoff.

Final Answer: $\phi = 0.75 \text{ cm/hr} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q31

Q32.

Solution

Concept – water application efficiency: $\eta_a = \dfrac{\text{water stored in the root zone}}{\text{water delivered to the field}} \times 100\%$.

Step 1 – list the quantities: Water delivered $= 100$ units, water stored in root zone $= 75$ units.

Step 2 – form the ratio: $\eta_a = \dfrac{75}{100}$

Step 3 – express as a percentage: $\eta_a = 0.75 \times 100$

$\eta_a = 75\%$

Why the other options are wrong:

- B, 133%: inverts the ratio; an efficiency cannot exceed 100%.
- A, 25%: is the fraction *lost*, not the fraction usefully stored.

Final Answer: $\eta_a = 75\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q32

Q33.

Solution

Concept – discharge from area and duty: $Q = \dfrac{A}{D}$, where A is the area irrigated and D the duty (area served per unit discharge).

Step 1 – list the data: $A = 8640$ ha, $D = 864$ ha/cumec.

Step 2 – divide the area by the duty: $Q = \dfrac{8640}{864}$

Step 3 – evaluate: $Q = 10\ \text{m}^3/\text{s}$

Step 4 – sanity check: A duty of 864 ha/cumec means each cumec serves 864 ha, so 8640 ha needs $8640/864 = 10$ cumec. Consistent.

Final Answer: $Q = 10\ \text{m}^3/\text{s} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept – return period from annual exceedance probability: $T = \frac{1}{P}$, the reciprocal of the probability of the event in any single year.

Step 1 – list the probability: $P = 0.02$.

Step 2 – take the reciprocal: $T = \frac{1}{0.02}$

Step 3 – evaluate: $T = 50$ years

Step 4 – interpret: On average this flood magnitude is equalled or exceeded once every 50 years.

Why the other options are wrong:

- A, 2 years and B, 20 years: correspond to probabilities of 0.5 and 0.05, not 0.02.
- D, 0.5 years: is less than a year and cannot be a return period for a 2% annual chance.

Final Answer: $T = 50$ years $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q34

Q35.

Solution

Concept – detention time is tank volume divided by flow rate: $t = \frac{V}{Q}$.

Step 1 – list the data: $V = 200\ \text{m}^3$, $Q = 800\ \text{m}^3/\text{day}$.

Step 2 – divide: $t = \frac{200}{800}$

$t = 0.25$ day

Step 3 – convert days to hours: $t = 0.25 \times 24$

$t = 6$ hours

Why the other options are wrong:

- A, 4 hours: would need $Q = 1200\ \text{m}^3/\text{day}$.
- D, 12 hours: doubles the correct value.

Final Answer: $t = 6$ hours $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q35

Q36.

Solution

Concept – chlorine demand: demand $=$ dose applied $-$ residual remaining.

Step 1 – list the data: Dose $= 3.0$ mg/L, residual $= 0.5$ mg/L.

Step 2 – subtract the residual from the dose: demand $= 3.0 - 0.5$

Step 3 – evaluate: demand $= 2.5$ mg/L

Step 4 – interpret: Of the 3.0 mg/L applied, 2.5 mg/L is consumed by the impurities in the water and 0.5 mg/L survives as free residual.

Final Answer: chlorine demand $= 2.5$ mg/L $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept – sewage flow as a fraction of water supplied: $Q_{\text{sewage}} = f \times q \times$ population, where f is the fraction of water returning as sewage.

Step 1 – compute the total water supplied per day: $q \times \text{pop} = 200 \times 100000 = 2 \times 10^7$ litres/day

Step 2 – apply the return fraction $f = 0.80$: $Q_{\text{sewage}} = 0.80 \times 2 \times 10^7$

$= 1.6 \times 10^7$ litres/day

Step 3 – convert litres to cubic metres (1000 L $= 1$ m^3): $Q_{\text{sewage}} = \dfrac{1.6 \times 10^7}{1000}$

$Q_{\text{sewage}} = 16000 \text{ m}^3/\text{day}$

Why the other options are wrong:

- A, 20000: is the full water supply without the 80% return factor.
- C, 1600 and D, 160000: misplace the litres-to-m^3 decimal.

Final Answer: $Q_{\text{sewage}} = 16000 \text{ m}^3/\text{day} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q37

Q38.

Solution

Concept – plume shape from atmospheric stability: The shape of a stack plume is governed by the vertical temperature structure of the atmosphere.

Step 1 – identify the stability state: The environmental lapse rate equals the dry adiabatic lapse rate, which is the **neutral** condition.

Step 2 – match the plume type to neutral conditions: In a neutral atmosphere the plume spreads at a steady, moderate rate in a cone about its axis, giving the **coning** plume.

Why the other options are wrong:

- A, looping: occurs in a strongly **unstable** (superadiabatic) atmosphere with vigorous convection.
- C, fanning: occurs under a **stable** atmosphere or inversion, where vertical spread is suppressed.
- D, fumigation: occurs when an unstable layer lies below an inversion, driving pollutants down to the ground.

Final Answer: coning $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q38

Q39.

Solution

Concept – total waste is the per-capita rate times the population: $M = q \times$ population, then convert to tonnes.

Step 1 – multiply the per-capita rate by the population: $M = 0.5 \times 200000$

$= 100000$ kg/day

Step 2 – convert kilograms to tonnes (1000 kg $= 1$ tonne): $M = \dfrac{100000}{1000}$

$M = 100$ tonnes/day

Why the other options are wrong:

- A, 400: over-counts the per-capita rate.
- B, 50: halves the population contribution.

Final Answer: $M = 100$ tonnes/day $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q39

Q40.

Solution

Concept – minimum curve radius from the superelevation equation: $e + f = \dfrac{V^2}{127\,R}$, which rearranges to $R = \dfrac{V^2}{127\,(e+f)}$, with V in km/h and R in m.

Step 1 – list the data: $V = 60$ km/h, $e + f = 0.15$.

Step 2 – square the speed: $V^2 = 60^2 = 3600$

Step 3 – compute the denominator: $127 \times (e+f) = 127 \times 0.15 = 19.05$

Step 4 – divide: $R = \dfrac{3600}{19.05}$

$R = 188.98 \approx 189$ m

Final Answer: $R \approx 189 \text{ m} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q40

Q41.

Solution

Concept – lag (reaction) distance: $d_{\text{lag}} = v \times t_r$, the distance travelled at constant speed during the driver's reaction time.

Step 1 – convert the speed to m/s: $v = 90 \text{ km/h} = \dfrac{90}{3.6} = 25 \text{ m/s}$

Step 2 – multiply by the reaction time: $d_{\text{lag}} = 25 \times 2.5$

Step 3 – evaluate: $d_{\text{lag}} = 62.5$ m

Why the other options are wrong:

- A, 25: is the speed in m/s, not a distance.
- B, 90: is the speed in km/h, again not a distance.

Final Answer: $d_{\text{lag}} = 62.5 \text{ m} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q41

Q42.

Solution

Concept – speed at maximum flow in Greenshields' model: The parabolic flow–speed curve peaks at half the free-flow speed, $v = \dfrac{v_f}{2}$.

Step 1 – list the data: Free-flow speed $v_f = 64$ km/h.

Step 2 – halve it: $v = \dfrac{64}{2}$

Step 3 – evaluate: $v = 32$ km/h

Step 4 – interpret: Maximum flow (capacity) occurs at $v_f/2$ and at density $k_j/2$; here that optimum speed is 32 km/h.

Why the other options are wrong:

- B, 64: is the free-flow speed, at which the flow is nearly zero.
- C, 16: is one-quarter of the free speed, not one-half.

Final Answer: $v = 32$ km/h $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q42

Q43.

Solution

Concept – rise-and-fall (or height-of-instrument) levelling: When only one instrument set-up is used, $\text{RL}_P = \text{RL}_{\text{BM}} + \text{BS} - \text{FS}$.

Step 1 – list the data: $\text{RL}_{\text{BM}} = 150.000$ m, BS $= 2.500$ m, FS $= 1.200$ m.

Step 2 – find the rise or fall between BM and P: BS $-$ FS $= 2.500 - 1.200 = +1.300$ m (a rise, since BS $>$ FS)

Step 3 – add the rise to the benchmark RL: $\text{RL}_P = 150.000 + 1.300$

$\text{RL}_P = 151.300$ m

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

Why the other options are wrong:

- A, 148.700: subtracts the rise instead of adding it.
- B, 153.700: adds both readings to the benchmark.

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

Answer: (C) Go Back to Q43

Q44.

Solution

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

Step 1 – count the sides: The traverse is a quadrilateral, so $n = 4$.

Step 2 – form $(2n+4)$**:** $2(4) + 4 = 8 + 4 = 12$

Step 3 – multiply by $90°$**:** $\sum = 12 \times 90°$

$\sum = 1080°$

Step 4 – cross-check against the interior-angle sum: The interior angles sum to $(2n-4) \times 90° = 4 \times 90° = 360°$, and $360° + 1080° = 1440° = 4 \times 360°$, as each interior/exterior pair totals $360°$. Consistent.

Why the other options are wrong:

- C, $360°$: is the sum of the **interior** angles of this quadrilateral, not the exterior angles.
- B, $720°$ and D, $540°$: do not satisfy $(2n+4) \times 90°$ for $n = 4$.

Final Answer: $\sum = 1080° \Rightarrow \boxed{\text{A}}$

Answer: (A) 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, $\Delta = 60°$.

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

Step 3 – evaluate the tangent: $\tan 30° = 0.57735$

Step 4 – multiply by the radius: $T = 200 \times 0.57735$

$T = 115.47$ m

Why the other options are wrong:

- C, 173.2: uses $\tan 60°$ instead of $\tan(\Delta/2) = \tan 30°$.
- B, 100: is $R\sin(\Delta/2)$-type slip, not the tangent length.

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

Answer: (D) Go Back to Q45

Q46.

Solution

Concept – tacheometric distance from the staff intercept: $D = k\,s + c$, where s is the staff intercept (upper hair reading minus lower hair reading).

Step 1 – compute the staff intercept: $s = 1.500 - 1.100 = 0.400$ m

Step 2 – list the constants: $k = 100$, $c = 0$.

Step 3 – substitute into $D = ks + c$: $D = 100 \times 0.400 + 0$

Step 4 – evaluate: $D = 40$ m

Why the other options are wrong:

- B, 130: uses the mean hair reading (1.300) instead of the intercept.
- D, 400: uses one of the individual readings scaled, not the intercept.

Final Answer: $D = 40$ m $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q46

Answer Key

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