

**GENERAL APTITUDE****Q. No. 1 – 5 Carry One Mark Each**

1. Daytime temperatures in Delhi can \_\_\_\_\_ 40°C

- (A) Peak (B) reach (C) get (D) stand

**Answer: (B)**

2. The growth rate of ABC Motors in 2017 was the same \_\_\_\_ XYZ Motors in 2016.

- (A) as those of (B) as that of (C) as that off (D) as off

**Answer: (B)**

3. Suresh wanted to lay a new carpet in his new mansion with an area of 70 x 55 sq. mts. However an area of 550 sq. mts had to be left out for flower pots. If the cost of carpet is Rs. 50 per sq. mts, how much money (in Rs.) will be spent by Suresh for the carpet now?

- (A) 1,65,000 (B) Rs. 1,92,500 (C) Rs. 1,27,500 (D) Rs. 2,75,000

**Answer: (A)**

4. A retaining wall with measurements 30 m × 12 m × 6m was constructed with bricks of dimensions 8 cm × 6cm × 6cm. If 60% of the wall consists of bricks used for the construction, the number of bricks is \_\_\_\_\_ lakhs

- (A) 45 (B) 30 (C) 40 (D) 75

**Answer: (A)**

5. Hima Das was \_\_\_\_ only Indian athlete to win \_\_\_\_ gold for India.

- (A) the, a (B) an, a (C) an, the (D) the, an

**Answer: (A)**

**Q. No. 6 - 10 Carry Two Marks Each**

6. Population of state X increased by  $x\%$  and the population of state Y increased by  $y\%$  from 2001 to 2011. Assume that  $x$  is greater than  $y$ . Let  $P$  be the ratio of the population of state X to state Y in a given year. The percentage increase in  $P$  from 2001 to 2011 is\_\_\_\_\_.

(A)  $x - y$                       (B)  $\frac{100(x - y)}{100 + x}$                       (C)  $\frac{100(x - y)}{100 + y}$                       (D)  $\frac{x}{y}$

**Answer: (B)**

7. The Newspaper reports that over 500 hectares of tribal land spread across 28 tribal settlements in Mohinitampuram forest division have already been “alienated”. A top forest official said, “First the tribals are duped out of their land holdings. Second, the families thus rendered landless are often forced to encroach further into the forests”. On the basis of the information available in the paragraph, \_\_\_\_ is/are responsible for duping the tribals.

- (A) The newspaper    (B) Landless families  
(C) forest officials    (D) it cannot be inferred who

**Answer: (D)**

8. An oil tank can be filled by pipe X in 5 hours and pipe Y in 4 hours, each pump working on its own. When the oil tank is full and the drainage hole is open, the oil is drained in 20 hours. If initially the tank was empty and someone started the two pumps together but left the drainage hole open, how many hours will it take for the tank to be filled? (Assume that the rate of drainage is independent of the head)

- (A) 2.50                      (B) 1.50                      (C) 2.00                      (D) 4.00

**Answer: (A)**

9. Mohan, the manager, wants his four workers to work in pairs. No pair should work for more than 5 hours. Ram and John have worked together for 5 hours. Krishna and Amir have worked as a team for 2 hours. Krishna doesnot want to work with Ram. Whom should Mohan allot to work with John, if he wants all the workers to continue working?

- (A) Amir                      (B) Krishna                      (C) Ram                      (D) None of three

**Answer: (B)**

10. “Popular Hindi fiction, despite – or perhaps because of – its wide reach, often does not appear in our cinema. As ideals that viewers are meant to look up to rather than identify with, Hindi film protagonists usually read books of aspirational value: textbooks, English books, or high value literature.”

Which one of the following CANNOT be inferred from the paragraph above?

- (A) Textbooks, English books or high literature have aspirational value, but not popular Hindi fiction
- (B) Protagonists in Hindi movies, being ideals for viewers, read only books of aspirational value
- (C) People do not look up to writers of textbooks, English books or high value literature
- (D) Though popular Hindi fiction has wide reach, it often does not appear in the movies

**Answer: (B)**

### CIVIL ENGINEERING

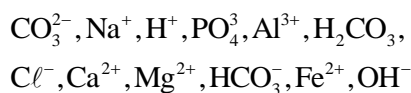
#### Q. No. 1 –25 Carry One Mark Each

1. What is the curl of the vector field  $2x^2yi + 5z^1j = 4yzk$  ?

- (A)  $-14zi - 2x^2k$
- (B)  $6zi + 4xj - 2x^2k$
- (C)  $6zi + 8xy + 2x^2yk$
- (D)  $-14zi + 6yj + 2x^2k$

**Answer: (A)**

2. Analysis of a water sample revealed that the sample contains the following species.



Concentrations of which of the species will be required to compute alkalinity?

- (A)  $\text{CO}_3^{2-}, \text{H}^+, \text{HCO}_3^-, \text{OH}^-$
- (B)  $\text{H}^+, \text{H}_2\text{CO}_3, \text{HCO}_3^-, \text{OH}^-$
- (C)  $\text{CO}_3^{2-}, \text{H}_2\text{CO}_3, \text{HCO}_3^-, \text{OH}^-$
- (D)  $\text{CO}_3^{2-}, \text{H}^+, \text{H}_2\text{CO}_3, \text{HCO}_3^-$

**Answer: (A)**

3. The value of the function  $f(x)$  is given at  $n$  distinct values of  $x$  and its value is to be interpolated at the point  $x^*$  using all the  $n$  points.

The estimate is obtained first by the Lagrange polynomial, denoted by  $I_L$ , and then by the Newton polynomial, denoted by  $I_N$ .

Which one of the following statements is correct?

- (A)  $I_L$  is always greater than  $I_N$
- (B) No definite relation exists between  $I_L$  and  $I_N$ .
- (C)  $I_L$  is always less than  $I_N$
- (D)  $I_L$  and  $I_N$  are always equal

**Answer: (D)**

4. If the fineness modulus of a sample of the fine aggregates is 4.3, the mean size of the particles in the sample is between

- (A) 150  $\mu\text{m}$  and 300  $\mu\text{m}$
- (B) 2.36 mm and 4.75 mm
- (C) 300  $\mu\text{m}$  and 600  $\mu\text{m}$
- (D) 1.18 mm and 2.36 mm

**Answer: (D)**

5. The command area of a canal grows only one crop, i.e., wheat. The base period of wheat is 120 days and its total water requirement,  $\Delta$ , is 40 cm. If the canal discharge is 2  $\text{m}^3/\text{s}$ , the area, in hectares, rounded off to the nearest integer, which could be irrigated (neglecting all losses), is \_\_\_\_\_.

**Answer: (5184)**

6. The characteristic compressive strength of concrete required for a project is 25 MPa and standard deviation in the observed compressive strength expected at site is 4 MPa. The average compressive strength of cubes tested at different water-cement (w/c) ratios using the same material as is used for the project is given in the table.

w/c(%)	45	50	55	60
Average compressive Strength of cubes (MPa)	35	25	20	15

The water-cement ratio (in percent, round off to the lower integer) to be used in the mix is \_\_\_\_\_.

**Answer: (46)**

7. A solid sphere of radius,  $r$ , and made of material with density  $\rho_s$ , is moving through the atmosphere (constant pressure,  $p$ ) with a velocity,  $v$ . The net force ONLY due to atmospheric pressure ( $F_p$ ) acting on the sphere at any time,  $t$ , is

(A)  $\frac{4}{3}\pi r^3 \rho_s \frac{dv}{dt}$  (B) zero (C)  $\pi r^2 p$  (D)  $4\pi^2 p$

Answer: (B)

8. An earthen dam of height  $H$  is made of cohesive soil whose cohesion and unit weight are  $c$  and  $\gamma$ , respectively. If the factor of safety against cohesion is  $F_c$ , the Taylor's stability number ( $S_n$ )

(A)  $\frac{\gamma H}{c F_c}$  (B)  $\frac{F_c \gamma H}{c}$  (C)  $\frac{c}{F_c \gamma H}$  (D)  $\frac{c F_c}{\gamma H}$

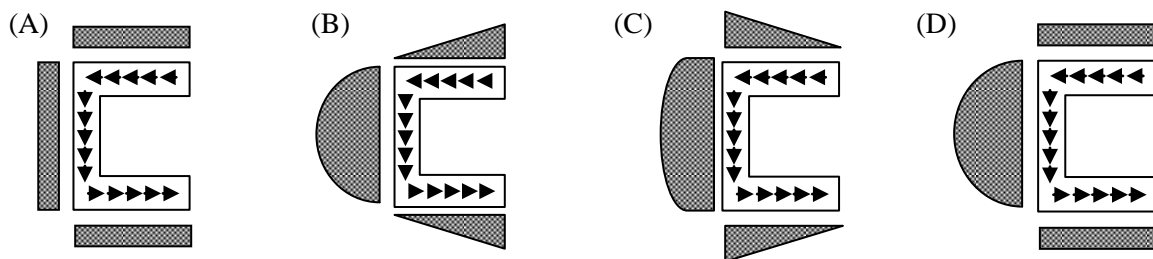
Answer: (C)

9. A closed thin walled tube has thickness,  $t$ , mean enclosed area within the boundary of the centerline of tube's thickness,  $A_m$ , and shear stress  $\tau$ . Torsional moment of resistance,  $T$  of the section would be

(A)  $2\tau A_m t$  (B)  $\tau A_m t$  (C)  $0.5\tau A_m t$  (D)  $4\tau A_m t$

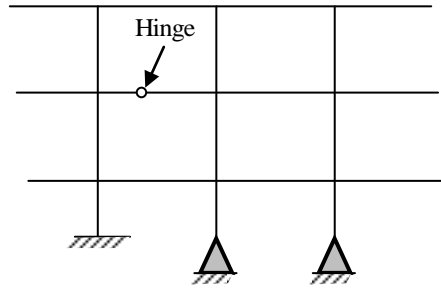
Answer: (A)

10. For a channel section subjected to a downward vertical shear force at its centroid, which one of the following represents the correct distribution of shear stress in flange and web?



Answer: (C)

11. The degree of static indeterminacy of the plane frame is shown in the figure is\_\_\_\_\_.



Answer: (15)

12. Structural failures considered in the mechanistic method of bituminous pavement design are

- |                        |                       |
|------------------------|-----------------------|
| (A) Fatigue and shear  | (B) Rutting and shear |
| (C) Shear and slippage | (D) Fatigue and Shear |

Answer: (D)

13. Which one of the options contains ONLY primary air pollutants?

- (A) Hydrocarbons and nitrogen oxides  
 (B) Nitrogen oxides and peroxyacetyl nitrate  
 (C) Ozone and peroxyacetyl nitrate  
 (D) Hydrocarbons and ozone

Answer: (A)

14. The following inequality is true for all  $x$  close to 0.

$$2 - \frac{x^2}{3} < \frac{x \sin x}{1 - \cos x} < 2$$

What is the value of  $\lim_{x \rightarrow 0} \frac{x \sin x}{1 - \cos x}$ ?

- |       |         |       |       |
|-------|---------|-------|-------|
| (A) 2 | (B) 1/2 | (C) 0 | (D) 1 |
|-------|---------|-------|-------|

Answer: (A)

15. The velocity field in a flow system is given by  $\mathbf{v} = 2\mathbf{i} + (x + y)\mathbf{j} + (xyz)\mathbf{k}$ . The acceleration of the fluid at (1, 1, 2) is
- (A)  $\mathbf{j} + \mathbf{k}$                       (B)  $2\mathbf{i} + 10\mathbf{k}$                       (C)  $4\mathbf{j} + 10\mathbf{k}$                       (D)  $4\mathbf{i} + 12\mathbf{k}$

**Answer: (C)**

16. A steel column is restrained against both translation and rotation at one end and is restrained only against rotation but free to translate at the other end. Theoretical and design (IS: 800 – 2007) values, respectively, of effective length factor of the column are
- (A) 1.0 and 1.0                      (B) 1.2 and 1.0                      (C) 1.0 and 1.2                      (D) 1.2 and 1.2

**Answer: (C)**

17. Euclidean norm (length) of the vector  $[4 - 2 - 6]^T$  is
- (A)  $\sqrt{48}$                       (B)  $\sqrt{24}$                       (C)  $\sqrt{12}$                       (D)  $\sqrt{56}$

**Answer: (D)**

18. An inflow hydrograph is routed through a reservoir to produce an outflow hydrograph. The peak flow of the inflow hydrograph is  $P_1$  and the time of occurrence of the peak is  $t_1$ . The peak flow of the outflow hydrograph is  $P_0$  and the time of occurrence of the peak is  $t_0$ .

Which one of the following statements is correct?

- (A)  $P_1 < P_0$  and  $t_1 > t_0$                       (B)  $P_1 > P_0$  and  $t_1 > t_0$   
(C)  $P_1 < P_0$  and  $t_1 < t_0$                       (D)  $P_1 > P_0$  and  $t_1 < t_0$

**Answer: (D)**

19. Construction of a new building founded on a clayey soil was completed in January 2010. In January 2014, the average consolidation settlement of the foundation in clay was recorded as 10 mm. The ultimate consolidation settlement was estimated in design as 40 mm. Considering double drainage to occur at the clayey soil site, the expected consolidation settlement in January 2019 (in mm, round off to the nearest integer) will be\_\_\_\_\_.

**Answer: (15)**

20. The notation “SC” as per Indian standard Soil Classification System refers to

- (A) Clayey silt (B) Sandy clay  
(C) Clayey sand (D) Silty clay

Answer: (C)

21. The speed-density relationship in a mid-block section of a highway follows the Greenshield’s model. If the free flow speed is  $v_f$  and the jam density is  $k_j$ , the maximum flow observed on this section is

- (A)  $\frac{v_f k_j}{2}$  (B)  $\frac{v_f k_j}{8}$  (C)  $v_f k_j$  (D)  $\frac{v_f k_j}{4}$

Answer: (D)

22. An anisotropic soil deposit has coefficient of permeability in vertical and horizontal directions as  $k_z$  and  $k_x$ , respectively. For constructing a flow net, the horizontal dimension of the problem’s geometry is transformed by a multiplying factor of

- (A)  $\frac{k_z}{k_x}$  (B)  $\frac{k_x}{k_z}$  (C)  $\sqrt{\frac{k_z}{k_x}}$  (D)  $\sqrt{\frac{k_x}{k_z}}$

Answer: (C)

23. The Laplace transform of  $\sinh(at)$  is

- (A)  $\frac{s}{s^2 - a^2}$  (B)  $\frac{s}{s^2 + a^2}$  (C)  $\frac{a}{s^2 - a^2}$  (D)  $\frac{a}{s^2 + a^2}$

Answer: (C)

24. The data from a closed traverse survey PQRS (run in the clockwise direction) are given in the table

Line	Included angle (in degree)
PQ	88
QR	92
RS	94
SP	89

The closing error for the traverse PQRS (in degrees) is\_\_\_\_\_.

Answer: (3)



25. A vehicle is moving on a road of grade +4% at a speed of 20 m/s. Consider the coefficient of rolling friction as 0.46 and acceleration due to gravity as  $10 \text{ m/s}^2$ . On applying brakes to reach a speed of 10 m/s, the required braking distance (in m, round off to nearest integer) along the horizontal, is \_\_\_\_\_.

**Answer: (30)**

**Q. No. 26 - 55 Carry Two Marks Each**

26. A broad gauge railway line passes through a horizontal curved section (radius = 875 m) of length 200 m. The allowable speed on this portion is 100 km/h. For calculating the cant consider the gauge as centre-to-centre distance between the rail heads, equal to 1750mm, The maximum permissible cant (in mm, round off to 1 decimal place) with respect to the centre-to-centre distance between the rail heads is \_\_\_\_\_.

**Answer: (157.5)**

27. When a specimen of M25 concrete is loaded to a stress level of 12.5 MPa, a strain of  $500 \times 10^{-6}$  is recorded. If this load is allowed to stand for a long time, the strain increases to  $1000 \times 10^{-6}$ . In accordance with provisions of IS: 456-2000, considering the long-term effects, the effective modulus of elasticity of the concrete (in MPa) is \_\_\_\_\_.

**Answer: (12500)**

28. The probability density function of a continuous random variable distributed uniformly between x and y (for  $y > x$ ) is

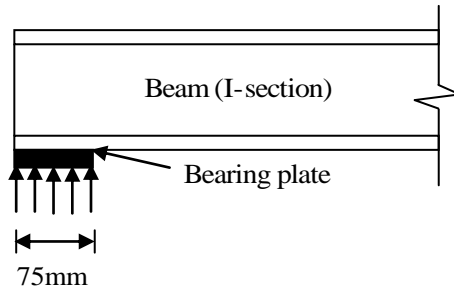
(A)  $\frac{1}{x-y}$                       (B)  $x-y$                       (C)  $y-x$                       (D)  $\frac{1}{y-x}$

**Answer: (D)**

29. The uniform arrival and uniform service rates observed on an approach road to a signalized intersection are 20 and 50 vehicles/minutes, respectively. For this signal, the red time is 30 s, the effective green time is 30 s, and the cycle length is 60s. Assuming that initially there are no vehicles in the queue, the average delay per vehicle using the approach road during a cycle length (in s, round off to 2 decimal places) is\_\_\_\_\_.

**Answer: (12.5)**

30. A rolled I-section beam is supported on a 75 mm wide bearing plate as shown in the figure. Thickness of flange and web of the I-section are 20 mm and 8mm, respectively. Root radius of the I-section is 10mm. Assuming: material yield stress,  $f_y = 250$  MPa and partial safety factor for material,  $\gamma_{mo} = 1.10$



As per IS: 800-2007, the web bearing strength (in kN, round off to 2 decimal places) of the beam is \_\_\_\_\_.

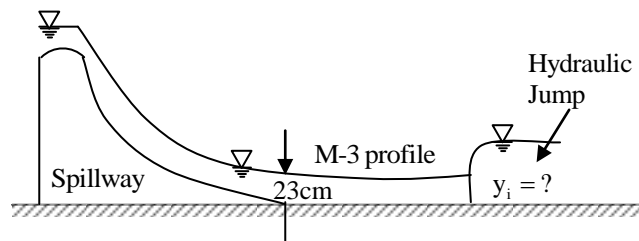
Answer: (272.23)

31. The critical bending compressive stress in the extreme fibre of a structural steel section is 1000 MPa. It is given that the yield strength of the steel is 250 MPa, width of flange is 250 mm and thickness of flange is 15 mm. As per the provisions of IS: 800-2007, the nondimensional slenderness ratio of the steel crosssection is

(A) 0.50 (B) 2.00 (C) 0.25 (D) 0.75

Answer: (A)

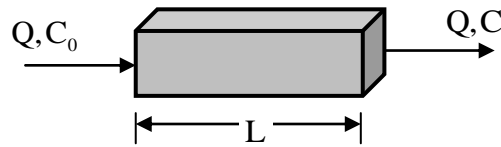
32. At the foot of a spillway, water flows at a depth of 23 cm with a velocity of 8.1 m/s, as shown in the figure.



The flow enters as an M-3 profile in the long wide rectangular channel with bed slope  $\frac{1}{1800}$  and Manning's  $n = 0.015$ . A hydraulic jump is formed at a certain distance from the foot of the spillway. Assume the acceleration due to gravity,  $g = 9.81$  m/s<sup>2</sup>. Just before the hydraulic jump, the depth of flow  $y_1$  (in m, round off to 2 decimal places) is \_\_\_\_\_.

Answer: (0.42)

33. Consider the reactor shown in the figure. The flow rate through the reactor is  $Q \text{ m}^3/\text{h}$ . The concentration (in  $\text{mg/L}$ ) of a compound in the influent and effluents are  $C_0$  and  $C$ , respectively.



The compound is degraded in the reactor following the first order reactions. The mixing condition of the reactor can be varied such that the reactor becomes either a completely mixed flow reactor (CMFR) or a plug-flow reactor (PFR). The length of the reactor can be adjusted in these two mixing conditions to  $L_{\text{CMFR}}$  and  $L_{\text{PER}}$  while keeping the cross-section of the reactor constant. Assuming steady state and for  $C/C_0 = 0.8$ , the value of  $L_{\text{CMFR}}/L_{\text{PER}}$  (round off to 2 decimal places) is \_\_\_\_\_

**Answer: (1.12)**

34. A series of perpendicular offsets taken from a curved boundary wall to a straight survey line at an interval of 6 m are 1.22, 1.67, 2.04, 2.34, 2.14, 1.87, and 1.15 m. The area (in  $\text{m}^2$ , round off to 2 decimal places) boundary by the survey line, curved boundary wall, the first and the last offsets, determined using Simpson's rule, is \_\_\_\_\_.

**Answer: (68.56)**

35. A water treatment plant treats  $6000 \text{ m}^3$  of water per day. As a part of the treatment process, discrete particles are required to be settled in a clarifier. A column test indicates that an overflow rate of 1.5 m per hour would produce the desired removal of particles through settling in the clarifier having a depth of 3.0 m. The volume of the required clarifier, (in  $\text{m}^3$ , round off to 1 decimal place) would be

**Answer: (500)**

36. A flexible pavement has the following class of loads during a particular hour of the day.

- (i) 80 buses with 2-axles (each axle load of 40 kN);
- (ii) 160 trucks with 2-axles (front and rear axle loads of 40 kN and 80 kN, respectively)

The equivalent standard axle load repetitions for this vehicle combination as per IRC:37-2012 would be

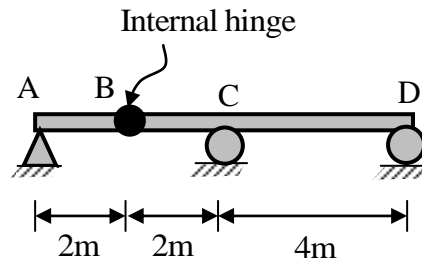
- (A) 320                      (B) 250                      (C) 240                      (D) 180

**Answer: (D)**

37. Constant head permeability tests were performed on two soil specimens, S1 and S2. The ratio of height of the two specimens ( $L_{S1} : L_{S2}$ ) is 1.5, the ratio of the diameter of specimens ( $D_{S1} : D_{S2}$ ) is 0.5, and the ratio of the constant head ( $h_{s1} : h_{s2}$ ) applied on the specimens is 2.0. If the discharge from both the specimens is equal, the ratio of the permeability of the soil specimens ( $k_{s1} : k_{s2}$ ) is \_\_\_\_\_.

Answer: (3)

38. A long uniformly distributed load of 10 kN/m and a concentrated load of 60 kN are moving together on the beam ABCD shown in the figure (not drawn to scale).



The relative positions of the two loads are not fixed. The maximum shear force (in kN, round off to the nearest integer) caused at the internal hinge B due to the two loads is \_\_\_\_\_.

Answer: (70)

39. A square footing of 2m sides rests on the surface of a homogeneous soil bed having the properties: cohesion  $c = 24$  kPa, angle of internal friction  $\phi = 25^\circ$ , and unit weight  $\gamma = 18$  kN/m<sup>3</sup>. Terzaghi's bearing capacity factor  $\phi = 25^\circ$  are  $N_c = 25.1$ ,  $N_q = 12.7$ ,  $N_\gamma = 9.7$ ,  $N'_c = 14.8$ ,  $N'_q = 5.6$  and  $N'_\gamma = 3.2$ . The ultimate bearing capacity of the foundation (in kPa, round off to 2 decimal places) is \_\_\_\_\_.

Answer: (353.92)

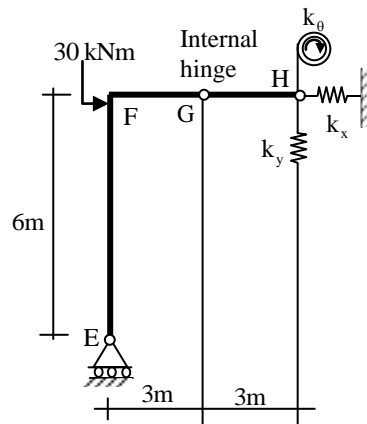
40. The dimensions of a soil sampler are given in the table.

Parameter	Cutting edge	Sampling tube
Inside diameter (mm)	80	86
Outside diameter (mm)	100	90

For this sampler, the outside clearance ratio (in percent, round off to 2 decimal places) is \_\_\_\_\_.

Answer: (11.11)

41. A plane frame shown in the figure (not to scale) has linear elastic springs at node H. The spring constants are  $k_x = k_y = 5 \times 10^5 \text{ kN/m}$  and  $k_\theta = 3 \times 10^5 \text{ kNm/rad}$ .



For the externally applied moment of 30 kNm at node F, the rotation (in degrees, round off to 3 decimals) observed in the rotational spring at node H is \_\_\_\_\_.

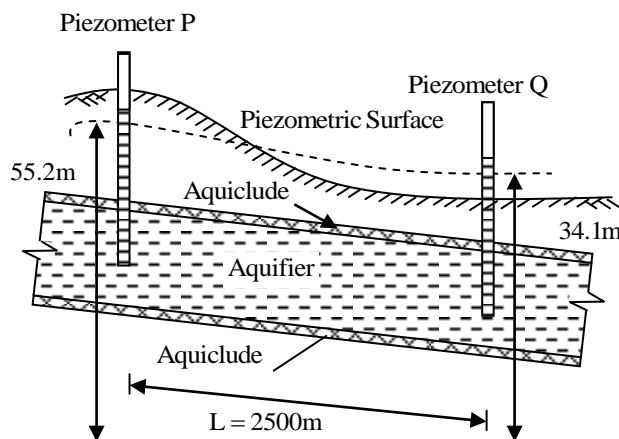
Answer: (0.006)

42. Chlorine is used as the disinfectant in a municipal water treatment plant. It achieves 50 percent of disinfection efficiency measured in terms of killing the indicator microorganisms (E-Coli) in 3 minutes. The minimum time required to achieve 99 percent disinfection efficiency would be

(A) 9.93 min (B) 11.93 min (C) 21.93 min (D) 19.93 min

Answer: (D)

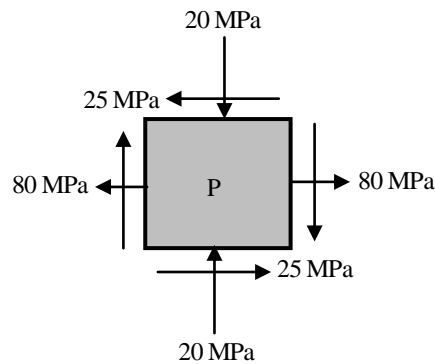
43. A confined aquifer of 15 m constant thickness is sandwiched between two aquicludes as shown in the figure (not drawn to scale)



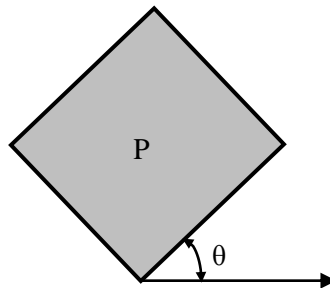
The heads indicated by two piezometers P and Q are 55.2 m and 34.1 m, respectively. The aquifer has a hydraulic conductivity of 80 m/day and its effective porosity is 0.25. If the distance between the piezometers is 2500 m, the time taken by the water to travel through the aquifer from piezometer location P to Q (in days, round off to 1 decimal place) is \_\_\_\_\_.

**Answer: (925.65)**

44. For a plane stress problem, the state of stress at a point P is represented by the stress element as shown in the figure.



By how much angle ( $\theta$ ) in degrees the stress element should be rotated in order to get the planes of maximum shear stress?



- (A) 26.6                      (B) 48.3                      (C) 31.7                      (D) 13.3

**Answer: (C)**

45. The inverse of the matrix  $\begin{bmatrix} 2 & 3 & 4 \\ 4 & 3 & 1 \\ 1 & 2 & 4 \end{bmatrix}$  is

(A)  $\begin{bmatrix} 2 & -\frac{4}{5} & -\frac{9}{5} \\ -3 & \frac{4}{5} & \frac{14}{5} \\ 1 & -\frac{1}{5} & -\frac{6}{5} \end{bmatrix}$  (B)  $\begin{bmatrix} -2 & \frac{4}{5} & \frac{9}{5} \\ 3 & -\frac{4}{5} & -\frac{14}{5} \\ -1 & \frac{1}{5} & \frac{6}{5} \end{bmatrix}$  (C)  $\begin{bmatrix} 10 & -4 & -9 \\ -15 & 4 & 14 \\ 5 & -1 & -6 \end{bmatrix}$  (D)  $\begin{bmatrix} -10 & 4 & 9 \\ 15 & -4 & -14 \\ -5 & 1 & 6 \end{bmatrix}$

Answer: (B)

46. Two identical pipes (i.e. having the same length, same diameter, and same roughness) are used to withdraw water from a reservoir. In the first case, they are attached in series and also discharge freely into the atmosphere. In the second case, they are attached in parallel and friction factor is same in both the cases, the ratio of the discharge in the parallel arrangement to that in the series arrangement (round off to 2 decimal places) is \_\_\_\_\_.

Answer: (2.83)

47. A camera with a focal length of 20 cm fitted in an aircraft is used for taking vertical aerial photographs of a terrain. The average elevation of the terrain is 1200 m above mean sea level (MSL). What is the height above MSL at which an aircraft must fly in order to get the aerial photographs at a scale of 1:8000?

- (A) 3200 m (B) 2800 m (C) 2600 m (D) 3000 m

Answer: (B)

48. Raw municipal solid waste (MSW) collected from a city contains 70% decomposable material that can be converted to methane. The water content of the decomposable material is 35%. An elemental analysis of the decomposable material yields the following mass percent.

C:H:O:N: other = 44:6:43:0.8:6.2

The methane production of the decomposable material is governed by the following stoichiometric relation  $C_a H_b O_c N_d + nH_2O \rightarrow mCH_4 + sCO_2 + dNH_3$

Given atomic weight: C = 12, H = 1, O = 16, N = 14. The mass of methane produced (in grams, round off to 1 decimal place) per kg of raw MSW will be \_\_\_\_\_.

Answer: (137.6)

49. In the context of provisions relating to durability of concrete, consider the following assertion:

**Assertion (1):** As per IS 456-2000, air entrainment to the extent of 3% to 6% is required for concrete exposed to marine environment.

**Assertion (2):** The equivalent alkali content (in terms of  $\text{Na}_2\text{O}$  equivalent) for a cement containing 1% and 0.6% of  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$  respectively, is approximately 1.4% (rounded to 1 decimal place).

Which one of the following statements is correct?

- (A) Assertion (1) is TRUE and Assertion (2) is FALSE
- (B) Both Assertion (1) and Assertion (2) are TRUE
- (C) Both Assertion (1) and Assertion (2) are FALSE
- (D) Assertion (1) is FALSE and Assertion (2) is TRUE

**Answer: (D)**

50. The ordinates,  $u$  of a 2-hour unit hydrograph (i.e. for 1 cm of effective rain), for a catchment are shown in the table.

Time	0	1	2	3	4	5	6	7	8	9	10	11	12
Ordinates	0	2	8	18	32	45	30	19	12	7	3	1	0

A 6-hour storm occurs over the catchment such that the effective rainfall intensity is 1 cm/hour for the first two hours, zero for the next two hours, and 0.5 cm/hour for the last two hours. If the base flow is constant at  $5 \text{ m}^3/\text{s}$ , the peak flow due to this storm (in  $\text{m}^3/\text{s}$ , round off to 1 decimal place) will be \_\_\_\_\_.

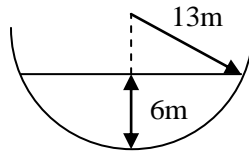
**Answer: (97)**

51. The speed-density relationship of a highway is given as  $u = 100 - 0.5k$  where,  $u$  = speed in km per hour,  $k$  = density in vehicles per km. The maximum flow (in vehicles per hour, round off to the nearest integer) is \_\_\_\_\_.

**Answer: (5000)**



52. Consider the hemi-spherical tank of radius 13 m as shown in the figure (not drawn to scale). What is the volume of water (in  $\text{m}^3$ ) when the depth of water at the centre of the tank is 6 m?



- (A)  $78\pi$  (B)  $468\pi$  (C)  $156\pi$  (D)  $396\pi$

**Answer: (D)**

53. A timber pile of length 8m and diameter of 0.2m is driven with a 20 kN drop hammer, falling freely from a height of 1.5m. The total penetration of the pile in the last 5 blows is 40mm. Use the engineering news record expression. Assume a factor of safety of 6 and empirical factor (allowing reducing in the theoretical set, due to energy losses) of 2.5 cm. The safe load carrying capacity of the pile (in kN, round off to 2 decimal places) is \_\_\_\_\_.

**Answer: (151.5)**

54. A  $2\text{m} \times 4\text{m}$  rectangular footing has to carry a uniformly distributed load of 120 kPa. As per the 2:1 dispersion method of stress distribution, the increment in vertical stress (in kPa) at a depth of 2 m below the footing is \_\_\_\_\_.

**Answer: (40)**

55. An ordinary differential equation is given below:

$$\left(\frac{dy}{dx}\right)(x \ell nx) = y$$

The solution for the above equation is (Note: K denotes a constant in the options)

- (A)  $y = K \ell nx$  (B)  $y = Kx \ell nx$   
(C)  $y = Kxe^x$  (D)  $y = Kxe^{-x}$

**Answer: (A)**