

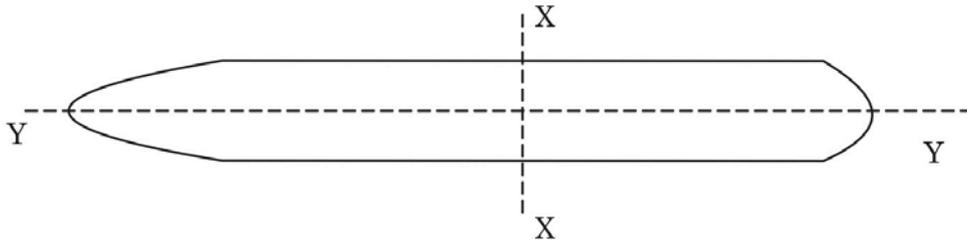
121/2022

Maximum : 100 marks

Time : 1 hour and 30 minutes

1. A steel bar 20 mm in diameter, when subjected to axial pull of 50 kN, elongates by 0.20 mm over a gauge length of 20 cm. The diameter of the bar is reduced by 0.004 mm. Bulk modulus of the material of the bar is :
(A) 88384 MPa (B) 159090 MPa
(C) 66288 MPa (D) 210524 MPa
2. A floor is supported by beams of rectangular cross section 7 cm wide, 20 cm deep and span 4.5 m. The floor carries a load of 10 kN/m². If the permissible bending stress in the beam is 8 MPa, the maximum permissible spacing of the beams is :
(A) 120 cm (B) 70 cm
(C) 15 cm (D) 10 cm
3. A hollow circular shaft has inner diameter of 90 mm and thickness 25 mm. The shaft is subjected to a torque of 12 kNm. If the modulus of rigidity of the material of the shaft is 80 GPa, the shear stress at the inner curved face of the shaft is :
(A) 17.26 MPa (B) 26.85 MPa
(C) 35.52 MPa (D) 53.70 MPa
4. Crippling load of column A is half of that of column B. If both the columns have the same height, end conditions of A and B are respectively :
(A) Both ends hinged, both ends fixed
(B) One end fixed the other free, both ends hinged
(C) Both ends fixed, one end fixed the other free
(D) One end fixed the other hinged, both ends fixed

8. The water plane area of a heavily bottom loaded cargo ship is shown in the Fig. below :

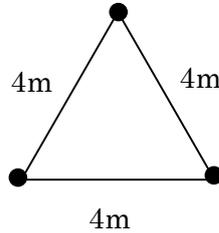


Choose the correct statement regarding the stability of the floating ship

- (A) The ship is least stable in pitching
 - (B) The ship is more stable in rolling
 - (C) The rotational stability about of YY axis is the design criteria
 - (D) The centre of buoyancy lies below the centre of gravity
9. If the contour values are 100, 110, 115, 120, 130 moving inwards, and all the contours are seemed to be touching each other at only one common point, the inference is that the terrain represented is :
- (A) an overhanging cliff
 - (B) a vertical hillside
 - (C) a gently sloping hill
 - (D) a pond
10. A Mass diagram is used for :
- (A) computation of cut and fill quantities and haul
 - (B) balancing cut and fill
 - (C) both (A) and (B)
 - (D) Neither (A) nor (B)
11. In transit theodolite, the verniers have a least count of :
- (A) 30 minutes
 - (B) 20 minutes
 - (C) 30 seconds
 - (D) 20 seconds
12. Bar bending schedule is made to :
- (A) estimate the quantity of bars needed
 - (B) to provide a drawing of bent bars
 - (C) to use reinforcement economically
 - (D) all of the above
13. How much quantity of gypsum shall be added to control the setting time of Portland cement during its manufacturing process?
- (A) 20 to 25%
 - (B) 25 to 30%
 - (C) 3 to 5%
 - (D) 15%

14. Which of the following is a key ingredient in the preparation of high performance concrete?
 (A) Silica fume (B) Volcanic ash
 (C) Blast furnace slag (D) Pumice
15. The curved triangular space formed between the extrados and the horizontal line through the crown is known as :
 (A) Voussoir (B) Springer
 (C) Arcade (D) Spandril
16. As per the specification in IS 456:2000, the transverse reinforcement for torsion shall be :
 (A) rectangular open stirrups placed perpendicular to the axis of the member
 (B) rectangular closed stirrups placed perpendicular to the axis of the member
 (C) rectangular closed stirrups placed at 45° to the axis of the member
 (D) rectangular open stirrups placed at 45° to the axis of the member
17. The development length required for a reinforcement bar of 12 mm diameter and grade Fe415, at a section where design bond stress is 1.92 MPa :
 (A) 353 mm (B) 438 mm
 (C) 564 mm (D) 648 mm
18. High strength concrete is necessary for prestressed concrete because it :
 (A) has high resistance to shrinkage crack
 (B) allows reduced cross section
 (C) has high bearing strength
 (D) all of the above
19. A double angle discontinuous strut consists of two identical angles placed back-to-back which are tack bolted. Comparing the compressive strength of two cases, viz., (i) Angles placed on opposite sides of the gusset plate (ii) Angles placed on the same sides of the gusset plate :
 (A) Case (i) greater than case (ii) (B) Case (i) less than case (ii)
 (C) Case (i) equal to case (ii) (D) Can be any of the above
20. A soil stratum is 10 m thick with pervious stratum on top and bottom. Determine the time required for 50% consolidation.
 Given :
 Coefficient of permeability = 10^{-7} cm/sec.
 Coefficient of compression = 0.0003 cm²/gm.
 Void ratio = 2
 Time factor = 0.197.
 (A) 950 days (B) 690 days
 (C) 570 days (D) 450 days

21. Plan of a three legged tower forms an equilateral triangle of side 4 m. If total weight of tower is 450 kN and is equally carried by all the legs. Compute the vertical stress increase in soil by the tower at a depth of 4 m directly below one of the legs :



- (A) 15 kN/m² (B) 6 kN/m²
 (C) 20 kN/m² (D) 45 kN/m²
22. The total unit weight of soil is 18.8 kN/m³, the specific gravity (G) of the solid particles of soil is 2.76 and the water content (w) of the soil is 12%. Calculate the void ratio :
- (A) 1.56 (B) 2.4
 (C) 0.89 (D) 0.56
23. What will be the ratio of average permeability in horizontal direction to that in the vertical direction (k_H/k_V) for a soil deposit consisting of 3 horizontal layers, if the thickness and permeability of the second layer are twice of those of the first and those of the third layer twice that of the second?
- (A) 9/7 (B) 7/6
 (C) 5/8 (D) 4/7
24. Height of buildings is strictly restricted in zoning when :
- (A) it affects aesthetics of the place (B) the site is close to an airport
 (C) the building is near a river (D) the building is built in a marsh
25. The facility in a port, to allow for ships to be taken on repair is known as :
- (A) Pier (B) Wharf
 (C) Dock (D) Apron
26. The resultant force of two equal forces P is also equal to P. The angle between them in degree is :
- (A) 30 (B) 60
 (C) 90 (D) 120
27. The unit of moment of force is :
- (A) N/m (B) Nm
 (C) N/m² (D) Nm²

28. Three forces A, B and C of magnitude 4N, 6N and 10N acting on a particle are in equilibrium. It can be concluded that :
- (A) A and B are perpendicular to each other
 - (B) B is non coplanar
 - (C) C is non concurrent
 - (D) B and C are acting in opposite direction
29. Which of the following elements has simple cubic structure?
- (A) Magnesium
 - (B) Polonium
 - (C) Titanium
 - (D) Aluminium
30. Which one of the following will decrease when the percentage of carbon increases?
- (A) Hardness
 - (B) Ductility
 - (C) Ultimate strength
 - (D) Percentage of cementite
31. The elongation of shaft A is four times the elongation of shaft B when subjected to equal tensile force. If the modulus of elasticity length of both shafts are the same then :
- (A) Diameter of A is half the diameter of B
 - (B) Diameter of A is twice the diameter of B
 - (C) Diameter of A is one-fourth the diameter of B
 - (D) Diameter of A is four time the diameter of B
32. The bulk modulus of metal A is twice of metal B and modulus of rigidity of A is three times of metal B, which one of the following is correct?
- (A) The modulus of Elasticity of A is three times of B
 - (B) The modulus of Elasticity of A is four times of B
 - (C) The modulus of Elasticity of A is six times of B
 - (D) The modulus of Elasticity of A is eight times of B
33. Which of the following statements is/are correct regarding the pressure angle of a cycloid gear tooth profile?
- (i) Pressure angle is constant throughout the profile
 - (ii) Pressure angle is zero at the pitch point
 - (iii) Pressure angle is maximum at the beginning and end of contact
 - (iv) Pressure angle varies from point to point
- (A) (i) only
 - (B) (ii) and (iii) only
 - (C) (iii) and (iv) only
 - (D) (ii), (iii) and (iv) only

34. Which of the following statements is/are true about contact ratio?
- (i) It measures the average number of teeth in contact during meshing
 - (ii) Contact ratio is always maintained at one
 - (iii) A lower contact ratio necessitates a higher degree of accuracy in machining
 - (iv) The angle of action must be greater than pitch angle
- (A) (i), (iii) and (iv) only (B) (i), (ii) and (iii) only
(C) (i) and (ii) only (D) (i) only
35. Which of the following statements is/are true about velocity ratio of worm gear drives?
- (i) Velocity ratio is the ratio of diameter of the worm wheel to the diameter of the worm
 - (ii) Velocity ratio is the ratio of number of teeth on the wheel to the number of teeth on the worm
 - (iii) Velocity ratio is the ratio of the number of teeth on the worm wheel to the number of starts on the worm
 - (iv) Velocity ratio is the ratio of speed of worm to the speed of worm wheel
- (A) (i) and (ii) only (B) (i) and (iii) only
(C) (iii) and (iv) only (D) (i) and (iv) only
36. The energy dissipated in viscous damping is proportional to :
- (A) The amplitude (B) Square of the amplitude
(C) Cube of the amplitude (D) $\sqrt{2}$ power of the amplitude
37. Which of the following statements is/are true with respect to Coulomb damping?
- (i) Damping force is constant
 - (ii) Damping force is independent of relative velocity
 - (iii) Damped natural frequency of vibration is same as undamped natural frequency
 - (iv) Loss of amplitude per cycle is four times the ratio of frictional force to stiffness
- (A) (i), (ii) and (iii) only
(B) (ii), (iii) and (iv) only
(C) (ii) and (iii) only
(D) (i), (ii), (iii) and (iv)
38. A cantilever beam of length L , moment of inertia I , and modulus of Elasticity E , carries a mass m , at its free end. What is the natural frequency of transverse vibrations neglecting the beam mass?
- (A) $\sqrt{\frac{EI}{mL^3}}$ (B) $\sqrt{\frac{2EI}{mL^3}}$
(C) $\sqrt{\frac{3EI}{mL^3}}$ (D) $\sqrt{\frac{4EI}{mL^3}}$

39. The relation between shear stress Z and velocity gradient $\left(\frac{du}{dy}\right)$ of a fluid given by

$Z = A\left(\frac{du}{dy}\right)^n$ where A and n are constants. If $n < 1$, What type of fluid will it be?

- (A) Newtonian fluid (B) Dilatant
(C) Pseudoplastic (D) Bingham plastic

40. The speed of water in a hose increased from 2m/s to 25m/s going from hose to the nozzle, given the absolute pressure in the nozzle is $1 \times 10^5 \text{ N/m}^2$ (atmospheric) assuming level frictionless flow. Calculate the pressure in the hose (density of water 1000 kg/m^3) :

- (A) $4.10 \times 10^5 \text{ N/m}^2$ (B) $3.10 \times 10^5 \text{ N/m}^2$
(C) $2.10 \times 10^5 \text{ N/m}^2$ (D) $5.24 \times 10^5 \text{ N/m}^2$

41. Pelton wheel is used in those places where :

- (A) high head and low discharge are available
(B) low head and high discharge are available
(C) high head and high discharge are available
(D) none of the above

42. The thermal conductivity of a solid depends upon the solids temperature as $K = aT + b$, where a and b are constants. The temperature of the planar layer of this solid as it conducts heat is given by :

- (A) $aT + b = x + C_2$ (B) $aT + b = C_1x^2 + C_2$
(C) $aT^2 + bT = C_1x + C_2$ (D) $aT^2 + bT = C_1x^2 + C_2$

43. The thermal resistance of heat conduction through a hollow sphere of inner radius r_1 and outer radius r_2 is :

- (A) $r_2 / 4\pi kr_1r_2$ (B) $\frac{r_2 - r_1}{4\pi kr_1r_2}$
(C) $\frac{r_1}{4\pi kr_1r_2}$ (D) $4\pi kr_1r_2$

44. It is proposed to coat a 1 mm diameter with enamel paint ($k = 0.1 \text{ w/mk}$) to increase the heat transfer with air. If the air side heat transfer coefficient is $100 \text{ w/m}^2\text{k}$, the optimum thickness of enamel paint should be :

- (A) 0.25 mm (B) 1 mm
(C) 0.5 mm (D) 2 mm

50. Which of the following is true for a gating system in casting?
- (i) A gating system may be composed of a runner, riser, sprue, etc.
 - (ii) A gating system should have sudden or right-angled changes in direction
 - (iii) A gating system should fill the mold cavity completely before freezing
- (A) Only (i) and (ii)
(B) All of the above (i), (ii) and (iii)
(C) Only (i) and (iii)
(D) None of the above (i), (ii) and (iii)
51. The energy required per unit mass to grind lime stone particle of very large size to $100\ \mu\text{m}$ is $12.7\ \text{Kwh/ton}$. An estimate (using Bonds law) of the energy to grind the particles from a very large size to $50\ \mu\text{m}$ is :
- (A) $6.35\ \text{Kwh/Ton}$ (B) $9.0\ \text{Kwh/Ton}$
(C) $18.0\ \text{Kwh/Ton}$ (D) $25.4\ \text{Kwh/Ton}$
52. What is the critical rotational speed in r.p.s. for a ball mill of $1.2\ \text{m}$ diameter charged with $70\ \text{mm}$ diameter balls?
- (A) 0.5 (B) 1.0
(C) 2.76 (D) 0.66
53. For a sphere falling in a constant drag coefficient regime, its terminal velocity depends on its diameter D as :
- (A) D (B) $D^{0.5}$
(C) D^2 (D) $1/D$
54. A 30% (by volume) suspension of spherical particles in a viscous oil has a hindered settling velocity of $4.4\ \mu\text{m/s}$. If the Richardson-zaki hindered settling index is 4.5 , then the terminal settling velocity of sand grain is :
- (A) $0.9\ \mu\text{m}$ (B) $1\ \mu\text{m}$
(C) $21.9\ \mu\text{m}$ (D) $0.02\ \mu\text{m}$
55. Separation factor of a cyclone separator having $0.5\ \text{m}$ diameter and tangential velocity of $20\ \text{m/s}$ is :
- (A) 40 (B) 80
(C) 160 (D) 240

56. A flue gas contains CO_2 , O_2 and N_2 . The mixture contains 14% CO_2 and 6% O_2 by mole. If the flue gas is at 200°C and 765 mm Hg pressure, partial pressure of N_2 in the mixture is :
- (A) 107 mm Hg (B) 212 mm Hg
(C) 50 mm Hg (D) 612 mm Hg
57. Wet leather with a moisture content 60% enters a drier and leaves with 10% moisture content. If the product flow rate is 500 kg/h, feed to the drier and water removed (in kg/h) are respectively :
- (A) 1125 and 625 (B) 1225 and 635
(C) 750 and 250 (D) 850 and 350
58. Pick out correct statement related with Amagat's law :
- (A) Volume of gas mixture equals sum of pure component volumes at the same temperature and pressure as that of the mixture
(B) Pressure of gas mixture equals sum of pure component pressures at the same temperature
(C) Partial pressure of a component in mixture is product of mole fraction and total pressure
(D) Both (B) and (C)
59. Dew point method can be used to measure :
- (A) Absolute humidity (B) Partial pressure of vapour
(C) Dew point (D) All the above
60. Gas expansion thermometers are based on the principle of :
- (A) Ideal gas law (B) Dalton's law
(C) Planck's law (D) Kirchoff's law
61. Which of the following is used for level measurement in open vessels?
- (A) rotameter (B) air-trap system
(C) hydrometer (D) hygrometer
62. Controller suitable for a process, where no offset is tolerable, is :
- (A) Proportional controller
(B) Proportional derivative controller
(C) Proportional Integral controller
(D) Proportional Integral Derivative controller

63. Transfer function of PD control is (K_c is gain, τ_D is derivative time and τ_I is integral time) :

(A) $\frac{P(s)}{\varepsilon(s)} = K_c(1 + \tau_D s)$

(B) $\frac{P(s)}{\varepsilon(s)} = K_c \left(1 + \tau_D s + \frac{1}{\tau_I s} \right)$

(C) $\frac{P(s)}{\varepsilon(s)} = \frac{K_c}{(1 + \tau_D s)}$

(D) $\frac{P(s)}{\varepsilon(s)} = \frac{K_c}{(1 + \tau_D s + \tau_I s)}$

64. Error detector is absent in :

(A) Feed back systems

(B) Open loop systems

(C) Closed loop systems

(D) All the above

65. If the temperature of the atmosphere increases at constant absolute humidity, the percentage saturation would be :

(A) Increase

(B) Remain constant

(C) Decrease

(D) First increase and then decrease

66. For a two phase feed, where 80% of the feed is vaporized under column condition, the feed line slope in the Mc Cabe-Thiele method for distillation column is :

(A) $-1/4$

(B) $1/4$

(C) 4

(D) -4

67. At 750 K and 1 atm, the approximate value of the Schmidt number for air is :

(A) 0.01

(B) 10

(C) 0.1

(D) 1

68. The absorption factor is defined as :

(A) L/mG

(B) G/mL

(C) mL/G

(D) LG/m

69. Simultaneous heat and mass transfer are occurring in a fluid over a flat plate. The flow is laminar. The concentration boundary layer will coincide with the thermal boundary layer, when :

(A) $Sc = Nu$

(B) $Sh = Nu$

(C) $Sh = Pr$

(D) $Sc = Pr$

70. In distillation column sizing calculations by short cut methods, match the following :

- | | | |
|-------------------------------|---|-------------------------------|
| P Underwoods equation | 1 | Number of real trays |
| Q Fenske equation | 2 | Column diameter |
| R Gilliland equation | 3 | Minimum Number of ideal trays |
| S Vapour velocity at flooding | 4 | Actual number of ideal |
| | 5 | Minimum reflux ratio |
| | 6 | Tray efficiency |

- (A) P-1, Q-3, R-4, S-6 (B) P-2, Q-5, R-1, S-3
(C) P-5, Q-3, R-6, S-2 (D) P-5, Q-3, R-4, S-2

71. Stereo specific polymers are produced by _____ type of polymerization.

- (A) Free radical (B) Cationic
(C) Coordination polymerization (D) Anionic

72. Styrene which is a monomer for the production of polystyrene is commercially produced by the :

- (A) Dehydration of ethyl alcohol followed by hydrogenation
(B) Reacting ethylene oxide with acetaldehyde
(C) Fermentation of starch
(D) Catalytic dehydrogenation of ethyl benzene

73. What is the role of potassium persulfate in polymerization reaction?

- (A) Stabilizer (B) Cooling agent
(C) Initiator (D) Terminating agent

74. Bulk polymerization is not suited for _____ type of reaction.

- (A) Highly exothermic reaction (B) Reversible reaction
(C) Highly endothermic reaction (D) Irreversible reaction

75. Nylon 66 is so named because :

- (A) The average degree of polymerization of the polymer is 1966
(B) The number of carbon atoms between two nitrogen atoms are 6
(C) The number of nitrogen atoms between two carbon atoms are 6
(D) The polymer was first synthesized in 1966

76. Free residual chlorine is seen in :
 (A) Natural water (B) Polluted water
 (C) Treated water (D) All of the above
77. Reciprocating pump is used for :
 (A) High discharge and high head (B) Low discharge and high head
 (C) High discharge and low head (D) Low discharge and low head
78. Which of the following is not tested during physical analysis of water?
 (A) Turbidity (B) Colour
 (C) Temperature (D) pH
79. Chemical formula for bleaching powder is :
 (A) $MgCl_2$ (B) $CaCl_2$
 (C) $CaOCl_2$ (D) $MgOCl_2$
80. Which of the following is the most destructive form of residual chlorine?
 (A) Hypochlorite ion (B) Hypochlorous acid
 (C) Monochloramines (D) Dichloramines
81. Which of the statement is true? Objective of Water audit is :
 (A) Water conservation (B) Quantify all the flow in a system
 (C) Reduce the water losses (D) All of the above
82. Surface loading for a rectangular sedimentation tank of length L, width B, height H and having a discharge Q is given by :
 (A) $\frac{Q}{BH}$ (B) $\frac{Q}{BL}$
 (C) $\frac{BLH}{Q}$ (D) $\frac{Q}{BLH}$
83. Flow through period of a sedimentation tank, when compared to its detention time is always :
 (A) more (B) less
 (C) equal (D) none of these
84. The method, which is most widely used for analyzing and designing the pipes of all types of complex water distribution networks, is :
 (A) Hardy cross method (B) Equivalent pipe method
 (C) Circle method (D) All of the above

85. Iron and manganese can be removed from water by :
- (A) Boiling (B) Chlorination
(C) Activated carbon (D) Aeration followed by coagulation
86. Chlorine demand of water is :
- (A) Applied chlorine (B) Residual chlorine
(C) (A) – (B) (D) (A) + (B)
87. Which of the following is not a coagulant?
- (A) Potassium permanganate (B) Alum
(C) Ferric chloride (D) Ferric sulphate
88. The efficiency of sedimentation tank does not depend upon :
- (A) Detention time (B) Depth of the tank
(C) Length of the tank (D) Horizontal velocity of water
89. The suitable layout for a water supply distribution system, for an irregularly grown town is :
- (A) Dead end system (B) Grid iron system
(C) Ring system (D) Radial system
90. In population forecasting, compared to the geometrical increase method, the arithmetical increase method gives :
- (A) Higher value (B) Lesser value
(C) Equal value (D) May vary
91. Pickup the incorrect statement :
- (A) Sewer pipes carry sewage flow by gravity
(B) Sewer pipe material has to withstand wear and tear due to abrasion
(C) Sewer pipes should be designed for a self-cleansing velocity of atleast 0.45 m/sec at minimum discharge or 0.8 m/sec at full discharge
(D) Sewer pipes can be carried up and down the hills and valleys
92. The specific gravity of sewage is :
- (A) Zero (B) Slightly less than 1
(C) Slightly greater than 1 (D) Equal to 1
93. If the depletion of oxygen is found to be 2 mg/l after incubating 3 ml of sewage diluted to 300 ml, at 20°C for 5 days, then the BOD₅ of the sewage would be :
- (A) 200 mg/l (B) 300 mg/l
(C) 600 mg/l (D) None of these

94. While testing for COD of sewage, organic matter is oxidized by $K_2Cr_2O_7$ in the presence of :
- (A) HCl (B) H_2SO_4
(C) HNO_3 (D) None of these

95. High COD to BOD ratio of an organic pollutant represents :
- (A) High biodegradability of the pollutant
(B) Low biodegradability of the pollutant
(C) Presence of free oxygen for aerobic decomposition
(D) Presence of toxic material in the pollutant

96. Primary treatment of sewage is meant for :
- (A) Removal of dissolved organic matter
(B) Removal of fine suspended organic matter
(C) Removal of larger suspended matter
(D) Removal of pathogenic bacteria

97. The following residual chlorine compounds are formed during chlorination of water :

1. NH_2Cl_2
2. $NHCl_2$
3. HOCl
4. OCl^-

The correct sequence of formation of these residual chlorine compounds is :

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

98. Imhoff cone is used to measure, in sewage :

- (A) Total solids (B) Total inorganic solids
(C) Total organic solids (D) Settleable solids

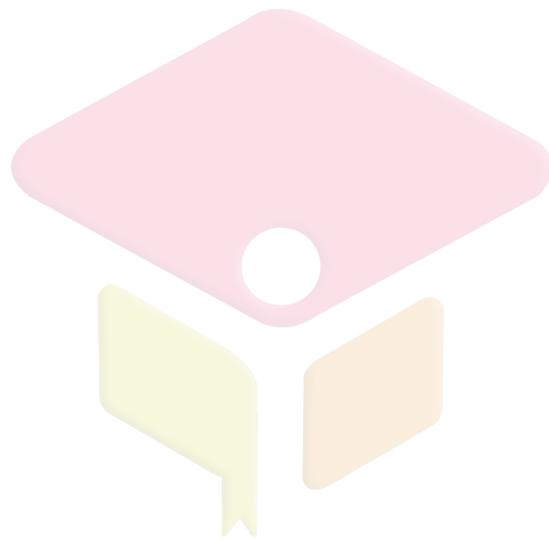
99. Standard 5 day BOD at $20^\circ C$, when compared to ultimate BOD, is about :

- (A) 58% (B) 68%
(C) 98% (D) None of these

100. The graph between the amount of organic matter left in sewage, and time elapsed in days is :

- (A) Linear (B) Parallel to time axis
(C) Exponential (D) None of these

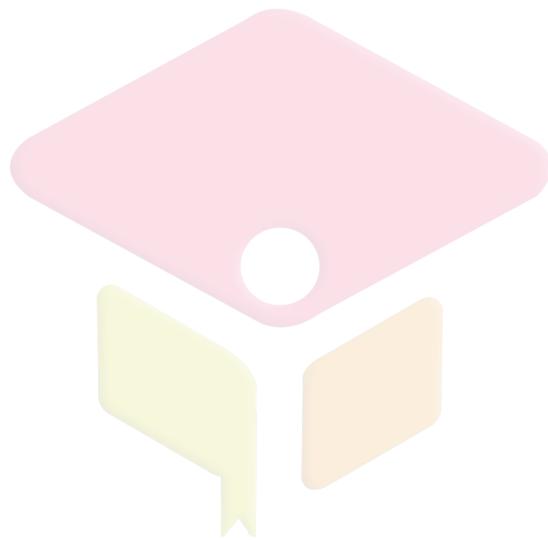
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