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॥ आपकी सफलता, हमारी प्रतिबद्धता ॥

1. Answer A

Solution

Sludge volume index (SVI) represents the degree of concentration of sludge in the system. It is equals to the volume occupied in ml by 1 gm of solid in the mixed liquor after settling for 30 minutes.

$$S.V.I = \frac{V_{ob} (ml/l)}{X_{ob} (mg/l)} \times 1000 ml/g$$

where

V_{ob} = If one litre sample of mixed liquor is allowed to settle for 30 min and then V_{ob} is settled volume.

X_{ob} = concentration of suspended solid in mixed liquor in mg/l.

$$\text{Here, } V_{ob} = 27 \text{ cm}^3 = 27 \text{ ml/l}$$

$$X_{ob} = 3000 \text{ mg/l}$$

$$\therefore SVI = \frac{27}{3000} \times 1000 \text{ ml/g}$$

$$SVI = 9 \text{ ml/gm}$$

Hence option (a) is correct.

2. Answer D

Solution

Table : Manhole spacing as per IS 1742 : 1960

Recommended spacing of manhole on straight reaches of sewer lines as per IS 1742-1960		Size of Sewer (m)
1.	45m	$\leq 0.3 \text{ m (upto)}$
2.	75m	$\leq 0.6 \text{ m (upto)}$
3.	90.	$\leq 0.9 \text{ m (upto)}$
4.	120m	$\leq 1.2 \text{ m (upto)}$
5.	250m	$\leq 1.5 \text{ m (upto)}$
6.	300m	$\geq 1.5 \text{ m (greater than)}$

3. Answer C

Solution

For sample A,

$$pH = -\log[H^+]$$

$$4.4 = -\log[H^+]$$

For sample B,

$$H^+ = 10^{-4.4}$$

$$H^+ = 10^{-6.4}$$

Sample A is $\frac{[H^+]_A}{[H^+]_B}$ times more acidic than B.

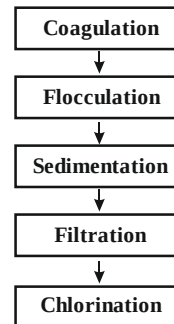
$$N = \frac{10^{-4.4}}{10^{-6.4}} \text{ time}$$

$$N = 100 \text{ time}$$

4. Answer D

Solution

sequence of processes in a conventional water treatment scheme is



5. Answer D

Solution

$$BOD = \frac{DO_i - DO_f}{\text{Dilution}} = \frac{9.5 - 2}{0.01} = 750 \text{ mg/l}$$

6. Answer D

Solution

As per IS 10500 : 2012, the maximum desirable limits of iron and fluorides for drinking water are 0.3 and 1.0 mg/L respectively.

7. Answer C

Solution

Chemical Oxygen Demand (COD): Amount of oxygen required to carryout the decomposition of total organic matter (biodegradable and non-biodegradable) present in the waste water. Whereas Biochemical Oxygen Demand (BOD) is the amount of oxygen required to carryout decomposition of biodegradable organic matter present in the waste water.

If water is having only biodegradable organic matter, then $BOD = COD$.

8. Answer C

Solution

Manhole type	Depth
Shallow manhole	100 mm to 900 mm
Medium manhole	900 mm to 1500 mm
Deep manhole	More than 1500 mm

9. Answer D

Solution

$$\text{Recirculation factor, } F = \frac{1 + \frac{R}{I}}{\left(1 + 0.1 \frac{R}{I}\right)^2}$$

$$F = \frac{1 + 1}{\left(1 + 0.1\right)^2} = 1.653$$

10. Answer A

Solution

Volume of tank = discharge $\times$ detention time

$$15 \times 6 \times 3 = \left(\frac{2 \times 10^6 \times 10^{-3}}{24} \right) \times t_d$$

$$t_d = \left(\frac{24 \times 15 \times 6 \times 3}{2 \times 10^3} \right) \text{hours}$$

$$t_d = 3.24 \text{ hrs}$$

11. Answer D

Solution

Sewage normally contain very small amount of solids in relation to the huge quantity of water (99.9%). It only contain about 0.05 to 0.17% of total solids

12. Answer C

Solution

Detritus tank separate non-decaying heavy inorganic material (like sand and girt) from sewage so that inorganic materials may be decomposed off without causing nuisance.

13. Answer B

Solution

- A. Grit chamber matches with 2. Two minutes (approx. 30-60 seconds to a couple of minutes).
- B. Primary sedimentation matches with 3. Two hours (approx. 2-2.5 hours).
- C. Activated sludge matches with 1. Six hours (approx. 4-6 hours).
- D. Sludge digestion matches with 4. Twenty days (approx. 20-30 days)

14. Answer B

Solution

In zone of active decomposition, the dissolved oxygen level is less than 40% of saturated DO. Minimum level of DO is also found in this zone.

15. Answer B

Solution

Alkalinity is defined as ability of water to neutralize the acid.

Major constituents are CO_3^{2-} and HCO_3^- and Minor constituent is OH

[OH⁻] is negligible so we don't consider in calculation

Hardness of water is defined as the concentration of multivalent metallic cations which destroy the

surfaced property of soap (Concentration of ions) which reacts with Soap and leads to the formation of a precipitate.

Ca^{2+} , Mg^{2+} are major constituents

Hardness is categorized into 2

Carbonate hardness and non-carbonate hardness

a) If $\text{TH} > \text{TA}$ Then, $\text{CH} = \text{TA}$

b) If $\text{TH} \leq \text{TA}$

Then $\text{CH} = \text{TH}$

16. Answer B

Solution

High COD to BOD ratio represents:

Low biodegradability of the pollutant.

High non-biodegradability of the pollutant.

17. Answer B

Solution

pH of fresh sewage is more than 7.

18. Answer D

Solution

Among given option SO_2 is not a coagulant.

19. Answer C

Solution

Coliform group of organism relates to presence of pathogenic bacterias.

20. Answer D

Solution

Population equivalent is the number of persons which produce the amount of BOD at the rate X gm per person per day equal to that produced by industrial sewage is called population equivalent of industrial sewage.

Population equivalent

$$= \frac{\text{Total BOD of industry in kg}}{\text{BOD per capital in kg / day / person}}$$

Here,

BOD of town = 20000 kg/day

BOD per capita per day,

X = 0.05 kg

Population equivalent

$$\frac{20000 \text{ kg / day}}{0.05 \text{ kg / day / person}} = 400,000$$

21. Answer B

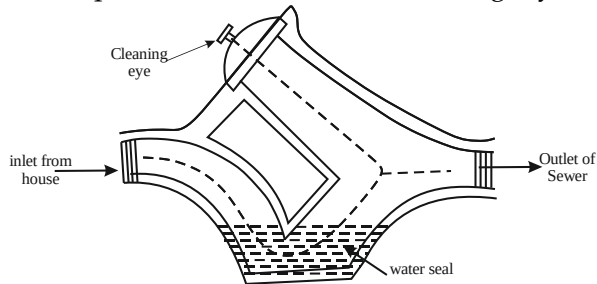
Solution

Scour valves are used to remove the entire water from the pipe. These valves are placed at bottom most point in the pipe.

22. **Answer B**

Solution

An intercepting trap is often provided at the junction of a house sewer and a municipal sewer, so as to prevent the entry of the foul gases of the municipal sewer, into the house drainage system.



23. **Answer B**

Solution

For safe and standard low-to-medium pressure boiler operations, total feedwater hardness must generally be limited to under **1 to 2 mg/l (or ppm)**

24. **Answer C**

Solution

Year	Population	Decadal increase
1970	40,000	
1980	46,000	6000
1990	53,000	7000
2000	58,000	5000

$$= \frac{6000 + 7000 + 5000}{3}$$

$$= 6000 \text{ per decade}$$

In 2010 population will be

$$P = 58000 + 6000 = 64000$$

25. **Answer D**

Solution

Standard average service life of common water supply pipes (as given in most Indian exam references like R.S. Khurmy):

Cast iron pipes → 100 years (most durable among the common materials)

Steel pipes → 40 years (prone to corrosion, shorter life)

The third material ; normally Concrete / Asbestos cement) → 75 years

26. **Answer A**

Solution

Check valves or Reflux valves: Check valves are sometimes called non-return valves because they prevent water to flow back in the opposite direction. They may be installed on the delivery side of the pumping set, so as to prevent the back flow of stored or pumped water, when the pump is stopped.

27. **Answer D**

Solution

High pH (alkaline) water in pipes tends to cause:

Incrustation → Precipitation of calcium carbonate and other salts forms hard scales inside the pipes.

Sediment deposits → Minerals settle out and form deposits.

Tuberculation, however, is caused by corrosion of iron/steel pipes. It forms nodular iron-oxide deposits (tubercles). This process is promoted by low pH (acidic/aggressive water), not high pH. High pH actually reduces corrosion and therefore does not produce tuberculation.

28. **Answer B**

Solution

Excess nitrates in drinking water cause Blue Baby Syndrome in infants.

Excess fluorides cause skeletal fluorosis (bones become brittle/embrittled).

Viruses (e.g., Hepatitis A virus) cause Infectious Hepatitis (water-borne).

Bacteria (Vibrio cholerae) cause Cholera.

29. **Answer C**

Solution

Ground water is free from suspended impurities.

However dissolved gases, salts and minerals are found in groundwater.

30. **Answer D**

Solution

The chlorine requirement for 200 ml water =

$$\frac{0.1 \times 200}{1000} \text{ mg}$$

Amount of bleaching powder solution needed

$$\frac{\text{Chlorine requirement}}{\text{Available Chlorine concentration}}$$

$$= \frac{0.1 \times 200}{1000 \times 0.3}$$

31. Answer B

Solution

In public water supply systems, a free residual chlorine of about 0.2 to 0.5 mg/L (ppm) is maintained at the consumer end for protection against pathogenic bacteria.

A minimum of ~0.2 ppm is needed throughout the distribution system to prevent recontamination.

Levels are kept in the range of 0.05–0.50 ppm (commonly cited as 0.2–0.5 ppm) so that the water remains safe without causing taste/odour problems.

Higher values (0.5–1.0 ppm or more) may be used temporarily during epidemics, but are not the normal residual for routine public supply.

32. Answer D

Solution

Rapid mixing (flash mixing) is done for a very short time (~30 seconds) at high intensity to disperse coagulant.

Flocculator needs gentle mixing for about 30 minutes so that flocs can grow.

Plain sedimentation tank typically has a detention time of 2–4 hours (commonly taken as 2–3 hours).

Tube settlers are high-rate settlers and require only 5–10 minutes detention time.

33. Answer C

Solution

Hydraulically equivalent square section is the one which gives the same discharge when running full at the same gradient. Circular sewer :

$$Q_c = \frac{1}{n} A_c R_c^{2/3} S^{1/2}$$

$$\text{Square sewer : } Q_s = \frac{1}{n} A_s R_s^{2/3} S^{1/2}$$

For hydraulic equivalence

$$\frac{\pi D^2}{4} \times \left(\frac{\pi D^2}{4 \times \pi D} \right)^{2/3} = B^2 \times \left(\frac{B^2}{4B} \right)^{2/3}$$

$$\frac{\pi D^2}{4} \times (D)^{2/3} = B^2 (B)^{2/3}$$

$$\left(\frac{D}{B} \right)^{8/3} = \frac{4}{\pi}$$

$$\frac{D}{B} = 1.095$$

34. Answer A

Solution

K_R varies with temperature as per the equation

$$K_{R(T)} = K_{R(20)} [1.016]^{T-20}$$

$$K_{R(22^\circ\text{C})} = 0.3 [1.016]^{(22-20)}$$

$$= 0.31$$

Note : De-oxygenation coefficient varies as

$$K_{D(T^\circ\text{C})} = K_{D(20)} [1.047]^{T-20}$$

35. Answer B

Solution

Supersaturation of a water body with dissolved oxygen ($\text{DO} > 100\%$ saturation) can occur due to intense photosynthetic activity by algae/plants or rapid changes in temperature/pressure.

This excess dissolved gas can come out of solution inside the bodies of fish, forming bubbles in the blood vessels, gills, fins, and tissues. The condition is known as gas bubble disease (or gas bubble trauma).

Eutrophication is caused by excess nutrients (N & P).

Methaemoglobinemia (Blue Baby Syndrome) is caused by high nitrates.

Endemic goitre is caused by iodine deficiency.

36. Answer B

Solution

$$\text{BOD}_{\text{mix}} = \frac{Q_S \text{BOD}_S + Q_R \text{BOD}_R}{Q_S + Q_R}$$

$$= \frac{50 \times 200 + 500 \times 8}{50 + 500}$$

$$= 25.45 \text{ mg/L}$$

37. Answer B

Solution

Refuse is a broad term covering all solid wastes (garbage + rubbish).

Sullage is wastewater from kitchens, bathrooms, wash basins etc. (no toilet waste) → relatively low organic/biodegradable content.

Sewage includes human excreta and is highly organic → higher decomposable fraction.

Rubbish refers to dry, non-putrescible combustible wastes (paper, wood, rags, etc.).



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38. **Answer D**

Solution

- (a) Contingencies are extra funds (usually 3% to 5%) kept for unexpected or minor miscellaneous expenses that planners missed.
- (b) Work charged establishment refers to the temporary, on-site technical and supervisory staff hired directly for the duration of the project.
- (c) Detailed specifications are exact documents that outline the quality, exact dimensions, and material ratios required for each construction item.

39. **Answer C**

Solution

Main subheads for building construction group large, predictable stages of work. Examples include Earthwork, Concrete Work, Brick Work, Stone Work, Roofing, Plastering, Finishing, Water Supply, and Sanitation. Patch work is a minor repair task, not a primary subhead for a new construction estimate.

40. **Answer D**

Solution

None of the given options are incorrect because statements (a), (b), and (c) are all accurate, standard technical definitions used in building estimation and civil engineering.

41. **Answer B**

Solution

Diameter Recommendation: In standard civil engineering and plumbing guidelines (such as IS 1742), a 150 mm pipe is the ideal baseline for domestic branch sewers to prevent blockages and handle wastewater discharge.

Gradient Efficiency: A gradient of 1 in 100 ensures that the wastewater flows at a self-cleansing velocity (minimum of 0.75 m/s) to flush out solid waste effectively.

Alternative Sizing: While 100 mm (10 cm) is sometimes used for small, isolated household connections, 150 mm is the universally recommended minimum for standard community or domestic sewers.

42. **Answer D**

Solution

Carpet area is the actual usable space inside the home where you can spread a carpet. It does not include external walls, bathrooms, corridors, or the kitchen.

43. **Answer D**

Solution

When calculating the total floor area of a building, engineers count only a portion of the balcony space. The standard building rule is to include balconies at 50% of their actual area if not covered, but if covered than 100% area should be taken.

44. **Answer C**

Solution

While submitting a tender, the contractor is required to deposit a certain percentage of the estimated cost as security against withdrawal of the tender or refusal to sign the contract if selected. This deposit is called Earnest money. (Once the contract is awarded, this may later be converted into or supplemented by "Security money" as performance security.)

45. **Answer B**

Solution

A Schedule of Rates lists all items of work along with their current rates, but without quantities for any specific project - it serves as a standard rate reference used to prepare estimates and tenders.

46. **Answer C**

Solution

In a Cost plus percentage contract, the contractor is reimbursed the actual cost incurred on labour and materials for the work, plus an agreed percentage of that cost as profit. This type of contract is generally used when the exact scope/quantities of work cannot be predetermined in advance, and it shifts most of the cost risk to the owner rather than the contractor.

47. **Answer A**

Solution

When additional works (not contemplated in the original estimate) become necessary during execution, a fresh detailed estimate covering only these additional works is prepared - this is called a Supplementary estimate. (A Revised estimate, by contrast, is prepared when the original sanctioned estimate itself is exceeded, e.g. due to price rise or design change, for the same scope of work.)

48. **Answer A**

Solution

Drawings show shape, size and layout, but details of material quality, workmanship and finish cannot be shown graphically - these are conveyed to the estimator through Specifications.

49. **Answer B**

Solution

This describes Salvage value the value of a property at the end of its useful life, without being dismantled.

50. **Answer A**

Solution

Scrap value is defined precisely as the value realizable from dismantled/demolished material, minus the cost incurred in dismantling it.

51. **Answer B**

Solution

As per common building bye-law provisions, when the abutting street width is 12 m or more, the permissible height of the building is generally restricted to 12 m (i.e. height not exceeding the street width for this bracket), subject to further FSI/setback rules of the local authority.

52. **Answer A**

Solution

Amalgamation is the term for combining two or more separate plots of land into a single plot for development purposes.

53. **Answer B**

Solution

Valuation is the process of estimating the worth of a property expressed in monetary terms.

54. **Answer B**

Solution

An Annuity Certain is one that is payable for a fixed, definite number of years/periods (as opposed to a Perpetual annuity, which continues indefinitely).

55. **Answer D**

Solution

Valuation: The art and technique of assessing the present fair value or price of an existing building or property at a specific time.

Estimation: The process of calculating the approximate or probable cost of a project *before* construction begins.

Costing: The process of tracking and calculating the actual expenses incurred to produce a product or build a structure.

Pricing: The business decision of setting the final sale amount or charge for goods and services

56. **Answer D**

Solution

Given: Road 1000 m long, 8 m wide, CC slab 15 cm thick over a 10 cm thick gravel sub-base.

Concept: "Box cutting" refers to excavating the full trench/box (down to the bottom of the sub-base) to receive both the gravel sub-base and the concrete slab - so the depth used is the total of both layers, not just the concrete alone.

Total depth = 0.15 + 0.10 = 0.25 m

Volume = $1000 \times 8 \times 0.25 = 2000 \text{ m}^3$

57. **Answer C**

Solution

Particulars of Item	Expected out-turn (sq. meter)
12 mm Plastering with cement or lime mortar	8.0
Pointing with cement or lime mortar	10.0
2.5 cm (1") C.C. floor	7.50
Sawing hardwood	4.00
Sawing of softwood	6.00

58. **Answer C**

Solution

Concept & Derivation: The "sloping surface" (the slant face of the embankment, not its horizontal projection) has a slope of s (horizontal) : 1 (vertical) and vertical rise = mean height d.

Concept :

Given data,

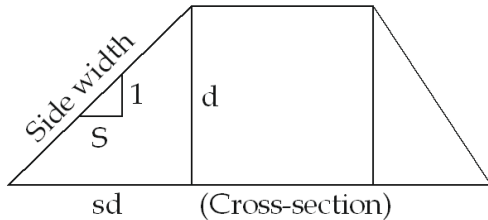
Length = L

Mean height = d

Side slopes = 5 : 1

Side width =

$$\sqrt{s^2 d^2 + d^2} = d \times \sqrt{1 + s^2}$$



Sloping surface area = length $\times$ side width =
 $1 \times d \times \sqrt{1 + s^2} = Ld \times \sqrt{1 + s^2}$

59. **Answer D**

Solution

Concept: In rate analysis, a unit rate is built up from: cost of materials (which depends on their specification/quality), cost of labour (which depends on the type of skill required by the work specification), and the specific proportions used (e.g., mortar ratio directly changes cement/sand quantities and hence cost). All three factors listed genuinely affect the rate.

60. **Answer A**

Solution

Step 1: Mortar volume in brickwork 23.05% of brick volume = $10 \times 0.2305 = 2.305 \text{ m}^3$ (wet mortar)

Step 2 - dry volume (factor 1.3) = $2.305 \times 1.3 = 3 \text{ m}^3$

Step 3 - cement share (1 : 6, total parts 7):

Cement = $3/7 \text{ m}^3$

61. **Answer C**

Solution

Concept: After totalling material cost, labour cost, and overheads (contingencies, water charges, tools & plant, establishment, etc.), a standard contractor's profit margin is added to arrive at the final rate. The conventionally accepted figure in Indian government rate analysis practice is:

62. **Answer C**

Solution

Step 1 - dry volume = $(8 \times 0.2305 \times 1.3) = 2.4$

Step 2 - sand share 1 : 3, total parts = 4, sand = 3 parts:

Sand = $2.4 \times (3/4) = 1.8 \text{ m}^3$

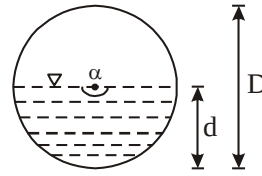
63. **Answer B**

Solution

$D = 1\text{m}$

$\alpha = 180^\circ$

$$\frac{V_{\text{half}}}{V_{\text{full}}} = \left(\frac{r}{R} \right)^{2/3}$$



$$\frac{V_{\text{half}}}{V_{\text{full}}} = \left[1 - \frac{360^\circ \sin \alpha}{2\pi \alpha} \right]^{2/3}$$

$$\frac{V_{\text{half}}}{V_{\text{full}}} = \left[1 - \frac{360^\circ \sin 180^\circ}{2\pi \times 180^\circ} \right]^{2/3}$$

$\sin 180^\circ = 0$

$V_{\text{half}} = V_{\text{full}} = 1\text{m}^3/\text{sec.}$

64. **Answer C**

Solution

- Proportional weir and Parshall flume are velocity control devices and it is provided at the end of the Grit chamber. Grit chambers are provided in order to carry out the removal of inorganic suspended solids.
- Fluoridation of water supplies to a level of 1 mg/l is safe and effective in reducing dental cavities. However, optimum concentration of fluoride has to be controlled because excessive amount leads to fluorosis, which caused decolouration of mottling of teeth and sometimes bone damage both in children and adults.
- Among all forms of nitrogen, nitrate is not harmful because it is fully oxidized. But too much of nitrate affects infants. The reason behind this is it causes blue baby disease or methemoglobinemia. Nitrate concentrations should not be more than 45 mg/l.
- Schmutzdecke is related to Slow sand filter. In slow sand filter when water passes through the filter medium, the upper layer of the medium is coated with sticky deposits of partially decompose of organic matter along with the nutrients, which promote the growth of algae that release O_2 during photosynthesis which is further utilized by the micro-organism to carry out the decomposition of organic matter. A thin biological layer over the filter medium, where this activity takes place is referred as Schmutzdecke.
- Solid's in water can be determined using the Gravimetric technique: Total solids can be

determined by heating the test sample at 104°C. Suspended solids are determined by passing the test sample through the filter and heating the residue left over the filter at 104°C. Organic solids or volatile solids both in total and suspended form can be determined by heating the test sample and residue leftover the filter at 600-650°C respectively in muffle furnace.

65. Answer A

Solution

Discharge in treatment plant = 1m³/s

Loading rate to filter = 120 m³/day/m² = 120/86400 = 0.00138 m³/s/m²

Combined loading rate of all filters

$$= \frac{1}{6 \times 10} = 0.01667 \text{ m}^3 / \text{s} / \text{m}^2$$

No. of filter units,

$$= \frac{\text{Combined loading rate of all filter}}{\text{Loading rate of one filter}}$$

$$\text{So, no of filter units} = \frac{0.01667}{0.00138} = 12$$

New loading rate after 2 filters are out of service

$$= \frac{0.01667}{10} \times 86400$$

$$= 144 \text{ m}^3 / \text{day} / \text{m}^2$$

66. Answer D

Solution

We know,

$$V_1(1 - P_1) = V_2(1 - P_2)$$

For sample A,

$$V_1(1 - 0.97) = V_2(1 - 0.95)$$

$$V_2 = \frac{0.03}{0.05} V_1 = 0.6V_1$$

$$\text{Decrease in volume} = \frac{V_1 - V_2}{V_1} \times 100$$

$$= \frac{V_1 - 0.6V_1}{V_1} \times 100 = 40\%$$

For sample B,

$$V_1(1 - 0.98)V_2(1 - 0.96)$$

$$V_2 = \frac{0.02}{0.04} V_1 = 0.5V_1$$

$$\text{Decrease in volume} = \frac{V_1 - 0.5V_1}{V_1} \times 100 = 50\%$$

67. Answer B

Solution

- Rate of filtration in 'slow sand filter' is 100 - 200 l/hr/m² or 2.4 m³/m²/day - 4.8 m³/m²/day

- Effective size of sand :

Slow sand filter	Rapid sand filter
(0.2-0.3)mm	(0.45-0.7)mm

- Period of cleaning is several years.
- 'Backwashing' is done in rapid sand filter to expand the granular base.

Time taken for backwashing is 15 minutes.

Amount of water required for backwashing is 2-5%.

- Uniformity coefficient D₆₀/D₁₀

Filter	Slow sand filter	Rapid sand filter
D ₆₀ /D ₁₀	1.8 - 3	1.3 - 1.7

68. Answer B

Solution

Activated sludge process is designed primarily for satisfaction of carbonaceous BOD which is done by heterotrophs.

69. Answer D

Solution

Size of Sewer	Recommended spacing of manholes on straight reaches of sewer line as per IS 1742:1960
Diameter upto 0.3 m	45 m
Diameter upto 0.6 m	75 m
Diameter upto 0.9 m	90 m
Diameter upto 1.2 m	120 m
Diameter upto 1.5 m	250 m
Diameter greater than 1.5 m	300 m

70. Answer C

Solution

The anaerobic sludge digester is a better method for handling the sludge because it produces a large amount of energy in the form of methane. It also reduces the nuisance of digested sludge and reduces the vectors such as rodents, flies, etc. attraction towards sludge.

Statement I is true and Statement II is false.

Other points about gas production in anaerobic sludge digester:

1. Out of total volatile solids, 65% are induced to gasses and 35% formed in digested sludge.
2. The total volume of gasses formed during digestion is either 0.6 m³/kg of volatile solids or 0.9 m³/kg of volatile solids reduce to gasses.
3. Out of the total gasses formed 70% is methane (CH₄) and 30% is carbon dioxide (CO₂).

71. Answer A

Solution

For sample number-3:

DO after 5 days 0 mg/l

Hence this data is to be neglected as nothing can be determined from this test.

Sample 1:

$$\text{BOD}(\text{DO}_i - \text{DO}_f) \times \text{dilution factor}$$

$$(9.2 - 6.9) \times \frac{300}{5} = 138 \text{ mg/l}$$

Sample 2:

$$\text{BOD}(9.1 - 4.4) \times \frac{300}{10} = 141 \text{ mg/l}$$

$$\text{Average BOD} = \frac{138 + 141}{2} = 139.5 \text{ mg/l}$$

Note: Sample-3 data is excluded.

As DO of 0 for sample 3

Hence, BOD cannot be determined for this sample.

72. Answer B

Solution

As per IS-10500:2012, Table 2

Permissible limit in absence of alternate source.

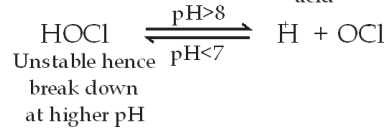
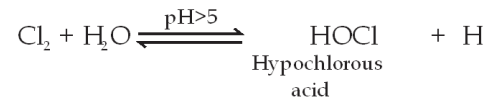
Chloride [as Cl⁻] Sulphate as [SO₄]-2

1000 mg/l 400 mg/l

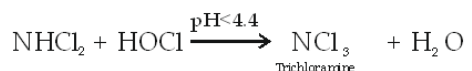
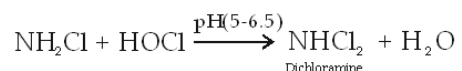
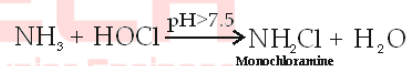
73. Answer B

Solution

Chlorination



- At pH < 5, chlorine does not react with water and remains as free chlorine.
- (HOCl + OCl⁻ and Cl₂) are combined called freely available chlorine. Out of these forms of freely available chlorine, HOCl is most destructive. It is 80% more effective than OCl⁻ ion. Hence pH of water should be maintained slightly below 7.
- Moreover chlorine will immediately react with ammonia present in water to form chloramines.



- Chloramines are combined form of chlorine. It is less effective than free chlorine (25 times lesser). But they are stable and remains in water for greater duration.
- In the usual chlorine treatment, in which pH is kept slightly less than 7, dichloramine is most predominant.

74. Answer B

Solution

- Alum is used as coagulant to form gelatinous white ppt. (floc) of aluminium hydroxide and its quantity is determined in the laboratory by jar test.
- The water of zero hardness can be obtained from the ion exchange method only. It is also called zeolite process of base exchange treatment. Lime soda process doesn't remove the complete hardness from the water.
- Winkler test is used to determine D.O. in water, it makes use of manganese salt iodide and hydroxide. In first step $Mn(OH)_2$ ppt. are formed. Then a strong acid is used to convert Iodide (I^-) to Iodine (I_2). The amount of dissolve oxygen is directly proportional to the titration of iodine with the sulphate solution.
- Oxidation pond employs algal bacterial symbiosis. On top, algae exist which produces oxygen by photosynthesis. This oxygen is used up by bacteria in breaking down of food.

75. Answer D

Solution

Laying of sewer pipes start from outfall end and proceed upwards. The sewer pipe are usually laid from lowest point with their socket ends facing upstream so that spigot end can be easily inserted in socket of already laid pipe.

Assertion (A) is wrong

The socket end faces upstream because there are high chances of sliding of them if faced downstream due to improper connection with spigot

Reason (R) is correct

76. Answer A

Solution

Method	Decomposition	Contact Mechanism
Trickling filter	Aerobic	Attached
Rotating biological /contractor	Aerobic	Attached
Activated sludge process	Aerobic	Suspended
Oxidation pond	Aerobic	Suspended
Septic tank	Anaerobic	Suspended
Sludge digestion tank	Anaerobic	Suspended

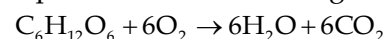
77. Answer C

Solution

When chemical formula and concentrations of different organic compounds is known, then theoretically calculating the oxygen required to completely oxidize the organic matter using balanced chemical equation is called as theoretical oxygen demand.

Given, concentration of glucose = 500 mg/L

Equation for oxidation of glucose



Molecular weight of glucose

$$12 \times 6 + 1 \times 12 + 16 \times 6 \Rightarrow 180 \text{ gm}$$

Molecular weight of oxygen

$$= O_2 \Rightarrow 16 \times 2 \Rightarrow 32 \text{ gm}$$

1 mole of glucose requires 6 moles of oxygen to oxidise hence 180 gm of glucose requires $6 \times 32 = 192$ gm of oxygen to oxidise

Hence, 500 mg/L glucose requires

$$= \frac{192}{180} \times 500 \text{ mg / L of oxygen}$$

$$= 533.33 \text{ mg/L of oxygen}$$

Note: Chemical oxygen demand (COD) of the raw water or waste water is used to measure the content of organic matter in waste water (both biodegradable and non biodegradable).

COD is determined by dichromate test.

78. Answer B

Solution

B.O.D. of 5 days

D.O. Consumed $\times$ Dilution factor

$$= (6 - 4) \times \frac{100}{1}$$

$$= 200 \text{ ppm}$$

79. Answer A

Solution

Schmutzdecke (German for "dirt cover" or "dirty skin") is a thin, gelatinous biological layer (biofilm) that forms on the surface of the sand bed in a **slow sand filter**.

Key points about Schmutzdecke

It develops naturally after the filter has been in continuous operation for some time (usually 1–3 weeks, known as the "ripening" period).

Composition: A complex matrix of bacteria, algae, fungi, protozoa, rotifers, and other microorganisms embedded in a sticky extracellular polymeric substance (EPS), along with trapped organic and inorganic particles.

80. Answer D

Solution

Sewers must maintain a self-cleansing velocity even at low flows. If the velocity drops too low, suspended solids settle and cause silting, blockage, and odour problems. Therefore, sewers are checked for adequate velocity under minimum flow conditions (this effect is more critical in smaller lateral sewers than in large trunk sewers).

Standard assumptions used in design (as per common Indian textbooks / CPHEEO / exam references)

$$\text{Minimum daily flow} = \frac{2}{3} \times \text{Annual Average}$$

Daily Flow (this is the value that occurs during night hours)

$$\text{Minimum hourly flow} = \frac{1}{2} \times \text{Minimum daily flow}$$

$$\text{Minimum hourly flow} = \frac{1}{3} \times \text{Annual Average}$$

Daily Flow

Other common design factors (for completeness)

Maximum daily flow $\approx 2 \times$ Average Daily Flow

Maximum hourly (peak) flow $\approx 3 \times$ Average Daily Flow (or sometimes taken as $1.5 \times$ maximum daily flow)

For treatment plant design, a peak factor of about 1.5 is often used.

Thus, the minimum daily flow occurring through the sewer during night hours is assumed as $\frac{2}{3}$ of the Average Daily Flow.