

$$\therefore \bar{x} = \frac{48000 - 28000}{20} = 1000$$

The Population when design capacity will be required,

$$P_n = \frac{6000 \times 1000}{150} = 40,000$$

∴ Number of years to reach the plant at design required,

$$n = \frac{P_n - P_o}{\bar{x}} = \frac{48000 - 28000}{20} \\ = 12.0 \text{ years}$$

Note: Since design capacity of treatment plant is done on the basis of times average daily demand not maximum daily demand, but in the given question solution is done on the basis of simply average daily demand otherwise answer will not match from any of the given option (data will be improper).

8. Match List-I (Pathogen) with List-II (Epidemic) and select the correct answer using the codes given below the lists:

List-I

- a. Virus
- b. Helminth
- c. Protozoa
- d. Bacteria

List-II

- 1). Worms
- 2). Polio
- 3). Cholera
- 4). Gastroenteritis

- A. A-2 B-4 C-1 D-3
C. A-1 B-2 C-3 D-4

- B. A-3 B-2 C-1 D-4
D. A-4 B-3 C-2 D-1

Ans. A

Sol. Virus-Polio

Helminth-Gastroenteritis

Protozoa-Worms

Bacteria-Cholera

9. Which of the following are not the essential characteristics of drinking water as per IS 10500 : 2012?

- A. Odour
C. pH
B. Taste
D. Lead

Ans. B

Sol. Taste is not an essential characteristics of drinking water as per IS 10500:2012.

10. Algae if present in drinking water:

- A. Clog filters and create impounded difficulties
- B. Impart coloration
- C. Produce taste and odour
- D. All of these

Ans. D

Sol. Algae gives false odour, imparts colour and clogs filters . copper sulphate is used to kill algae.

11. The water which is not chemically pure but does not contain anything harmful to human health is called as

- A. Pure water
- B. Distilled water
- C. Drinking water
- D. Wholesome water

Ans. D

Sol. Pure water, distilled water and drinking water all are chemically pure whereas wholesome water is the water which in itself does not contain any harmful particles but has not been chemically processed to remove impurities.

12. 'Methemoglobinemia' disease to children is caused due to excess presence of

- A. Nitrates
- B. Nitrites
- C. Free ammonia
- D. Albuminoid nitrogen

Ans. A

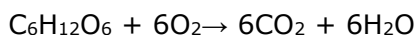
Sol. Nitrates are fully oxidized nitrogen compounds. They don't possess any threat in adults but if present in concentration more than 45 mg/l cause a disease called methemoglobinemia in small children. Due to this disease, the color of baby changes to blue and hence it is also known as blue baby diseases.

13. What will be the maximum upper limit of BOD of a glucose solution of concentration 300 mg/l?

- A. 321 mg/l
- B. 327 mg/l
- C. 333 mg/l
- D. 340 mg/l

Ans. A

Sol. Water contains only glucose which is oxidised under following equation



180 grams of glucose + 192 grams of oxygen → 264 grams of carbondioxide + 108 grams of H₂O

From this balanced equation of oxidation of glucose, it can be stated that the theoretical

oxygen demand of glucose is $\frac{192}{180} = 1.07$ mg of O₂/mg of glucose

16. Match the class of the type of disease causing organisms in the first column with the diseases caused in second column.

P. Bacteria - 1) Amoebic dysentery

Q. Virus - 2) Cholera

R. Protozoa - 3) Echinococcosis

S. Helminth - 4) Polio

A. P-1, Q-2, R-3, S-4

B. P-2, Q-4, R-3, S-1

C. P-2, Q-4, R-1, S-3

D. P-4, Q-2, R-3, S-1

Ans. C

17. Which of the pairs is/are not correctly matched?

Contaminant → Harmful effect in water

A. Copper – Creates Respiratory problems

B. Arsenic – Increases risk of hypertension

C. Fluoride – Causes damage to liver

D. Nitrates – Toxic to infants causes blue baby disease

Ans. C

Sol. Higher concentration of fluorides causes mottling of teeth (fluorosis)

18. The hardness of a water sample is measured directly by titration with 0.1 M solution of ethylenediamine tetraacetic acid (EDTA) using eriochrome black T (EBT) as an indicator. The EBT reacts and forms complexes with divalent metallic cations present in the water. During titration, the EDTA replaces the EBT in the complex. When the replacement of EBT is complete at the end point of the titration, the colour of the solution changes from

A. reddish brown to pinkish yellow

B. blue-green to reddish brown

C. blue to colourless

D. wine red to blue

Ans. D

Sol. Wine red to blue.

19. **Assertion (A):** Coagulation is the process of charge neutralization on colloids.

Reason (R): Flocculation is the process to grow the chargeless colloids into settleable flocs.

A. Both A and R are true and R is the correct explanation of A

B. both A and R are true but R is not a correct explanation of A

C. A is true but R is false

D. A is false but R is true

Ans. C

Sol. Coagulation is the process of charge neutralization on colloids

Flocculation is the process to grow the charged colloids into settleable flocs.

20. A sedimentation tank is to be designed to treat one lakh cum of water per day. If the settling velocity of the particles to be removed is 40 m/day then area of the tank required is?

- A. 3000 m²
C. 2000 m²

- B. 2500 m²
D. 1500 m²

Ans. B

Sol. $Q = 100000 \text{ m}^3/\text{day}$

$V_s = 40 \text{ m/day}$

Therefore, $V_s = \frac{Q}{A_s} = \frac{100000}{40} = 2500 \text{ m}^2$

21. The settling velocity of grit particles if specific gravity of grit is 2.8, particle's size is 0.25 mm and viscosity of water is $1 \times 10^{-2} \text{ m/s}$ will be (Take $g = 10 \text{ m/s}^2$):

- A. 0.25 m/s
C. 0.05 m/s
B. 25.0 m/s
D. 0.005 m/s

Ans. B

Sol. settling velocity of particle of size less than 1mm $V = g(G-1)d^2 / \{18 \cdot \nu\}$
 $= 10 \cdot 1.8 \cdot 0.25^2 / (18 \cdot 0.01) = 25 \text{ m/s}$

22. 15 MLD of water is flowing through a 2.0 km long pipe of diameter 40 cm. The chlorine at the rate of 27 kg/d is applied at the entry of this pipe so that disinfected water is obtained at the exit. There is a proposal to increase the flow through this pipe to 20 MLD from 15 MLD. Assume the dilution coefficient, $n = 1$. The minimum amount of chlorine (in kg per day) to be applied to achieve the same degree of disinfection for the enhanced flow is:

- A. 48 kg/d
C. 35 kg/d
B. 30 kg/d
D. None of these

Ans. A

Sol. We know, $tc^n = k$

where C is the concentration and n is the direction coeff.

t is time required to kill organism.

Here $n = 1$

$$t = \frac{L}{V}$$

where, L = length of pipe

V = velocity of flow

$$t = \frac{L}{V} = \frac{L}{Q/A}$$

$$t = \frac{LA}{Q}$$

$$L = \frac{W}{Q}$$

where, W = weight of disinfectant/day

Q = discharge/day

$$t_1 C^{n_1} = t_2 C^{n_2}$$

$$\frac{LA}{Q_1} \times \frac{w_1}{Q_1} = \frac{LA}{Q_2} \times \frac{W_2}{Q_2} \times$$

$$\therefore W_2 = \frac{Q_2^2}{Q_1^2} \times W_1$$

$$= \left(\frac{20}{15}\right)^2 \times 27 = 48 \text{ kg/d}$$

23. When chlorine is dissolved in water, it reacts to form hypochlorous acid and hypochlorite ions. At pH < 5, chlorine exists in water as
- Elemental or molecular chlorine
 - Remains in the form of hypochlorous acid
 - Remains in the form of hypochlorite ions
 - Remains in the form of both hypochlorous acid and hypochlorite ions

Ans. A

Sol. When pH < 5, during the chlorine and water reaction, chlorine does not react with water and it will remain in elemental form.

24. Flocculation is the process of
- Gently mixing the water and coagulant allowing the formation of large particles of floc
 - Removing relatively large floating and suspended debris
 - Flow, which is slowed enough so that gravity will cause the floc to settle
 - Mixture of solids and liquids collected from the settling tank are dewatered and disposed of

Ans. A

Sol. Flocculation is the slow mixing process, in which flocks will be formed where as coagulation is the fast mixing process in which neutralization of negative charge takes place.

25. A water treatment plant of capacity, 1 m³/s has filters of dimensions 6 m x 10 m. Loading rate of the filters is 120 m³/day/m². When two of the filters are out of service for backwashing, the loading rate (in m³/day/m²) is
- | | |
|--------|--------|
| A. 144 | B. 244 |
| C. 154 | D. 164 |

Ans. A

$$\text{Area of filters required} = \frac{1m^3 / s}{120m^3 / day / m^2} \quad \text{Number of filters required} = \frac{720m^3}{6 \times 10m^2} = 12$$

Sol. $= \frac{86400m^3 / day}{120m / day} = 720m^2$

When two filters are out of service, number of filters available = 10

$$\text{Loading rate with 10 filters} = \frac{86400m^3 / day}{(6 \times 10) \times 10} = 144m^3 / day / m^2$$

26. A city has a population of 100000 with an average rate of demand of 160 litres per head per day. What is the actual number of filters required if the size of each filter is 9m x 5m? Assume the average filtration rate as 4500 litres per hour per m².

Calculate chlorine dose at breakthrough point

- A. 1 B. 2
C. 4 D. 5

Ans. D

Sol. Maximum daily discharge = 1.5 x 160 x 100000 = 24MLD

$$\text{Area of filter required} = \frac{24 \times 10^6 \text{ It. / day}}{4500 \times 24 \text{ It. / day / m}^2}$$

$$= 222.22m^2$$

$$\text{Numbe of filter required} = \frac{222.22}{45} = 4.938 \approx 5 = 5 \text{ filters}$$

27. The chlorine dosage for the treatment of 20000 cum if water per day is 0.5 mg/l. The residual chlorine after 10 min contact is 0.2 mg/l. The chlorine demand of water in mg/l is:

- A. 0.5 B. 0.4
C. 0.3 D. 0.2

Ans. C

Sol. Chlorine dose = Chlorine demand + Residual chlorine

$$\text{Chlorine demand} = 0.5 - 0.2 = 0.3 \text{ mg/l}$$

28. Removal of iron from water can be done by:

- A. Oxidation with chlorine B. Oxidation with bromine
C. Oxidation with KMnO₄ D. Both A and B

Ans. A

29. Which of the following statement is incorrect?

- A. Fluorides, in water, can be removed by activated alumina.
B. Breakpoint chlorination is required to ensure free chlorine residuals for better disinfection.
C. During water treatment process, propeller mixing unit have a detention period of 30 sec.
D. In slow sand filters, as compared to rapid sand filters, effective size of sand is less but uniformity coefficient is more.

Ans. C

Sol. During water treatment process, propeller mixing unit have a detention period of 10 sec.

30. For a grit channel, if the recommended flow velocity is 0.25 m/s and the detention period is 1 minute, the length of the tank is:

- A. 15 m
- B. 25 m
- C. 32.5 m
- D. 40 m

Ans. A

Sol. Length = flow velocity x detention time

$$= 0.25 \times 60 = 15 \text{ m}$$

31. At a water treatment plant, the coagulation sedimentation unit clarifies 40 million litres of water each day. The quantity of alum required at the plants is 18 mg/lit. If the alkalinity of raw water is 5 mg/lit as CaCO_3 . Find out the quantity of alum and quicklime (having 85% of cao) required on yearly basis of the plant.

- A. Alum : 125.044 tonn/year; Quicklime = 262.80 tonn/year
- B. Alum : 162.80 tonnes/year; Quicklime = 25.044 tonnes/year
- C. Alum : 262.80 tonnes/year; Quicklime = 125.044 tonnes/year
- D. Alum : 62.80 tonnes/year; Quicklime = 25.044 tonnes/year

Ans. C

Sol. Quantity of water treated per day = 40 ML

$$\text{Quantity of alum required} = 40 \times 10^6 \times 18 \times 10^{-6}$$

$$= 720 \text{ kg/day}$$

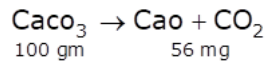
$$= \frac{720 \times 365}{1000} \text{ tonnes/year}$$

$$= 262.80 \text{ tonnes/year}$$

Alkalinity deficiency = Alkalinity required - Alkalinity present

$$= 18 - 5$$

$$= 13 \text{ mg/lit}$$



$$\text{Amount of Cao required} = \frac{56}{100} \times 13 \text{ mg/lit}$$

$$= 7.28 \text{ mg/lit}$$

$$\text{Dose of quicklime required} = \frac{7.28}{0.85}$$

$$= 8.5647 \text{ mg/lit.}$$

$$\text{Quantity of quicklime required per year} = \frac{8.5647 \times 10^{-6} \times 40 \times 10^6 \times 365}{1000}$$

$$= 125.044 \text{ tonnes/year}$$

32. Statement-I: Disinfection refers to the rendering of harmless pathogenic organisms.
Statement-II: Sterilization refers to the killing of all organism.

- A. I is true, II is false
- C. I is false, II is false

- B. I is false, II is true
- D. I and both are true

Ans. D

33. During water purification, which of the following process reduces the net electrical repulsive force at particle surfaces by adding specific chemicals?

- A. Flocculation
- C. Oxidation
- B. Agglomeration
- D. Coagulation

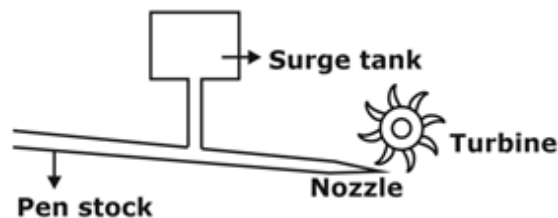
Ans. D

34. Which one of the following is the purpose of providing surge tank in pipelines carrying water?

- A. To store water
- B. To increase pressure in the pipeline
- C. To store overflowing water
- D. To protect the pipeline against water hammer

Ans. D

Sol.



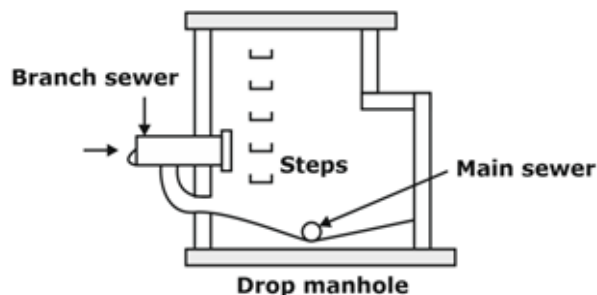
Surge tank is provided to store the excess water in pipeline due to sudden closing at downstream. If this tank is not provided, the water wave will travel upstream and cause water hammer pressure.

35. An appurtenance used to connect high level branch sewer to low level branch sewer is

- A. Manhole
- C. Inverted siphon
- B. Drop manhole
- D. Catch basin

Ans. B

Sol. A manhole which is constructed to connect the high level branch sewer (>0.6m) to the low level main sewer by vertically dropping pipe is known as drop manhole



36. Which one of the pipe fittings has least frictional resistance in equivalent pipe lengths in terms of the diameter of the pipe

- A. Sharp elbow
- C. Reflux Valve

- B. T-connection
- D. Sluice elbow

Ans. D

Sol. Approximate loss coefficient, k for commercial pipe fittings:

Type and position of fittings	Values of k
Globe valve, wide open	10
Globe valve, wide open	0.2
Globe valve, three quarter open	1.15
Globe valve, half open	5.6
Globe valve, quarter open	24
Pump foot valve	1.5
90° elbow (threaded)	0.9
45° elbow (threaded)	0.4
Side outlet of T junction	1.8

37. Ball valve is used:

- A. For isolating
- B. For reversal of flow
- C. For maintaining constant level of water
- D. None of these

Ans. A

Sol. Ball valve is used for isolation of flow.

38. An appurtenance used to connect high level branch sewer to low level branch sewer is

- A. Manhole
- B. Drop manhole
- C. Inverted siphon
- D. Catch basin

Ans. B

39. The type of value, which is provided to control flow of water through pipe line:

- A. Check valve
- B. Reflux valve
- C. Scour valve
- D. Sluice valve

Ans. D

Sol. Check valve/Reflux valve: To Present back water flow in the pipe line.

Scour valve: To remove silt from the pipe line

Sluice valve/Gate valve: To control flow of water through pipeline.

40. Consider the following statements regarding valves in a pipe line:

- 1). In long pipe lines, air will accumulate in the low point of the line and will interfere with the flow
- 2). Pressure relief valves are used in pipe lines where pressure may increase beyond the maximum permissible pressure.
- 3). Non-return valves prevent water flowing back, i.e. in the opposite direction.

Which of the above statements are correct?

- A. 1 and 2 only
 B. 2 and 3 only
 C. 1 and 3 only
 D. 1, 2 and 3

Ans. B

41. A waste water stream (flow = $3 \text{ m}^3/\text{s}$, ultimate BOD = 80 mg/l) is joining a small river (flow = $12 \text{ m}^3/\text{s}$, ultimate BOD = 10 mg/l). Both water streams get mixed up instantaneously. Cross-sectional area of the river is 30.0 m^2 . Then the velocity of river flow will be:

- A. 0.3 m/s
 B. 0.5 m/s
 C. 1.5 m/s
 D. None of these

Ans. B

Sol. $Q=12+3=15\text{m}^3/\text{s}$

$$V=Q/A=15/30=0.5\text{m/s}$$

42. 'if B.O.D. of waste water sample after 5 days incubation at 20° C is 100 mg/l , deoxygenation rate constant at 20° C is 0.1 per day, ultimate B.O.D. will be

- A. 120.20 mg/l
 B. 146.25 mg/l
 C. 200.45 mg/l
 D. 225.60 mg/l

Ans. B

Sol. $\text{BOD}_5 = \text{BOD}_u [1 - 10^{-k \times 5}]$

$$100 = \text{BOD}_u [1 - 10^{-0.1 \times 5}]$$

$$\text{BOD}_u = 146.25 \text{ mg/l}$$

43. The BOD_5 of a wastewater sample is 200 mg/litre at 20°C . The value of the reaction constant is $K = 0.2 \text{ day}^{-1}$ with base 'e'. The ultimate BOD of the sample is

- A. 126 mg/litre
 B. 544 mg/litre
 C. 146 mg/litre
 D. 316 mg/litre

Ans. D

Sol. $\text{BOD}_5 = \text{BOD}_u(1-e^{-kt})$

$$= \text{BOD}_u(1-e^{-0.2 \times 5})$$

$$200 = \text{BOD}_u(1-e^{-1})$$

$$\text{BOD}_u = 316 \text{ mg/litre}$$

44. Match List-I (Standard of sewage effluents for the discharge in surface water sources) with List-II (Tolerance limits in mg/l) and select the correct answer using the codes given below the lists:

List-I

- a. COD
 b. Oil and grease
 c. BOD_5
 d. Total suspended solids

List-II

- 1). 30
 2). 20
 3). 250

4). 10

A. A-2 B-4 C-1 D-3

B. A-3 B-4 C-2 D-1

C. A-1 B-2 C-3 D-4

D. A-4 B-3 C-2 D-1

Ans. B

Sol.

BOD ₅	20
COD	250
OIL AND GREASE	10
TOTAL SUSPENDED SOLIDS	30

45. Higher value of COD/BOD ratio indicates that:

A. Waste water is difficult to biograde.

B. Waste water is easy to biograde

C. Waste water contains lesser toxic wastes

D. Biodegradability of waste water does not depend upon COD/BOD ratio.

Ans. A

Sol. High value of COD/BOD ratio in an indication that waste water is difficult to biograde.

46. Correct sequence of detention time of various treatment unit is:

A. Grit chamber < Activated sludge tank < Primary sedimentation tank < oxidation pond

B. Primary sedimentation tank < Grit chamber < Oxidation pond < Activated sludge tank.

C. Grit chamber < Primary sedimentation tank < Activated sludge tank < Oxidation pond

D. Activated sludge tank < Grit chamber < Primary sedimentation tank < Oxidation pond

Ans. C

Sol.

Unit	Detention time
Grit chamber	60s-120s
PST	2h
Activated sludge	4-6h
Oxidation pond	15-20 days

47. Effluent from wastewater treatment plant (flow rate = 6 m³/s, Temperature = 25°C) is discharged to a surface stream (Flow rate 1.2 m³/s, Temperature = 15°C). What is the temperature of the stream after mixing?

A. 10°C

B. 15.77° C

C. 20°C

D. 23.33°C

Ans. D

Sol. Temperature of the mix = $T_{\text{mix}} = \frac{Q_1 T_1 + Q_2 T_2}{Q_1 + Q_2} = \frac{6 \times 25 + 1.2 \times 15}{6 + 1.2} = 23.33 \text{ } ^\circ\text{C}$

48. Consider the following parameters:

1. Fixed solids

2. Volatile solids

3. Chemical oxygen demand

4. Biochemical oxygen demand

5. Dissolved oxygen

Which of these parameters are taken into consideration for determining organic strength of a waste?

A. 1,2 and 3

B. 2, 3 and 4

C. 3, 4 and 5

D. 1, 4 and 5

Ans. B

Sol. Organic strength of waste is determined by BOD. The organic particles are volatile solids and they reduce dissolved oxygen of water. However measurement of dissolved oxygen is not necessary. Some of the organic matter is refractory (non-biodegradable) in nature. This can be measured by COD. COD is more than BOD

49. Which of the following represents a very old lake which has almost become marshy?

A. Oligotrophic

B. Mesotrophic

C. Eutrophic

D. Senescent

Ans. D

Sol. Oligotrophic: lake with low level of productivity.

Mesotrophic: lake with medium algal growth.

Eutrophic: lake with high productivity and algal growth.

50. The stages of zone of pollution in the river stream from upstream to downstream are

A. Zone of active decomposition, zone of degradation, zone of clearer water, zone of recovery.

B. Zone of degradation, zone of active decomposition, zone of recovery, zone of clearer water.

C. Zone of clearer water, Zone of active decomposition, zone of degradation, zone of clearer water, zone of recovery.

D. None of these

Ans. B

Sol. Stages of Zones of pollution

Zone of degradation, Zone of active decomposition, Zone of recovery and Zone of clearer water.

51. If average daily discharge is $28 \text{ m}^3/\text{sec}$ for a sewage in a city, then Maximum hourly discharge will be

A. $84 \text{ m}^3/\text{sec}$

B. $168 \text{ m}^3/\text{sec}$

C. $42 \text{ m}^3/\text{sec}$

D. $19 \text{ m}^3/\text{sec}$

Ans. A

Sol. Maximum hourly discharge = $3 \times$ Average daily discharge = $84 \text{ m}^3/\text{sec}$

52. Before entering a manhole a candle is lowered into the manhole

A. to illuminate it

- B. to detect toxic gases
- C. to give a signal to the adjacent manhole
- D. to find out the presence of oxygen

Ans. D

Sol. Before entering a manhole a candle is lowered into the to find out the presence of oxygen.

53. A: Sanitary pipes should be laid out straight as far as possible.

R: Straight piping reduces plumbing cost.

- A. Both A and are true and R is the correct explanation of A
- B. Both A and R are true, but R is not the correct explanation of A
- C. A is true, but R is false
- D. A is false, but R is true

Ans. A

Sol. Sanitary pipes should be laid out straight as far as possible because straight piping reduces plumbing cost.

54. The minimum size of RCC manhole cover in a sewer system is

- A. 30 cm diameter
- B. 40 cm diameter
- C. 50 cm diameter
- D. 100 cm diameter

Ans. C

Sol. A manhole is an opening constructed on the alignment of a sewer for facilitating a person's access to the sewer for the purpose of inspection, testing, cleaning and removal of obstruction from the sewer line.

The minimum size for RCC manhole cover is 50 cm diameter.

55. A sewer line of diameter 800 mm is to be laid in a colony. The recommended spacing of manholes in straight reaches as per IS 1742 would be:

- A. 45 m
- B. 75 m
- C. 90 m
- D. 120 m

Ans. C

Sol. As per IS 1742:

Size of sewer	Recommended spacing of manholes on straight + Reaches
Dia up to 0.3 m	45 m
upto 0.6 m	75 m
upto 0.9 m	90 m
upto 1.2 m	120 m
upto 1.5 m	250 m
> 1.5 m	300 m

56. For a design of a storm sewer in a drainage area, if the time of concentration is 20 minutes, then the duration of rainfall is taken as:

- A. 10 min
- B. 20 min
- C. 30 min
- D. 40 min

Ans. B

Sol. Maximum runoff will be obtained from the rain having a duration equal to the time of concentration, and this is called as critical rainfall. Therefore, duration of rainfall should be 20 min.

57. Which is the best sewer material to resist hydrogen sulphide corrosion?

- A. Glazed stoneware
- B. Glazed earthenware
- C. RCC
- D. Brick masonry

Ans. A

Sol. Glazed stoneware or vitrified clay pipes have the advantage of being highly resistant to sulphide corrosion.

58. Match List-I and List-II and select the correct answer using the code given below the lists:

List-I

- (i) Sluice valve
- (ii) Drain Valve
- (iii) Air relief valve
- (iv) Reflux valve

List-II

- 1. Where submains branch off
- 2. In service pipe connection
- 3. At high elevation points
- 4. At low level reaches

Codes

- A. i- 1 ii - 3 iii- 4 iv - 2
- B. i- 2 ii - 4 iii- 3 iv - 1
- C. i- 1 ii - 4 iii- 3 iv - 2
- D. i- 2 ii - 3 iii- 4 iv - 1

Ans. C

Sol. i) Gate valve or sluice valve are used to regulate the flow of water through the pipes. In large pipe lines, they are located along the pipeline at intervals of 3 to 5 kilometres, so as to divide the pipelines into different sections.

ii) Air relief valve are required to be provided at all summits to remove the accumulated air after repairs.

iii) Blow off valves or drain valves remove the entire water from within a pipe. They are necessary at flow level points for completely emptying the pipes for inspection, repairs etc.

iv) Check valves or reflux valves prevent water to flow back to opposite directions. They are provided on delivery side of pumping set and at interconnections between a polluted water system and a potable water system

59. The ventilation in sewers is needed to avoid the

- A. Development of explosive mixtures of sewers gases
- B. Build-up of odorous gases
- C. Danger of asphyxiation of sewer maintenance employees
- D. Anaerobic decomposition of organics

Ans. A

Sol. Although all the reasons are correct but 1 is the most appropriate reason.

Ventilation of sewers is needed to avoid the development of explosive mixtures of sewers gases which may cause huge trouble to the livelihood as it can catch fire if those gases concentrate at a place.

60. An appurtenance used to connect high level branch sewer to low level branch sewer is
- A. Manhole
 - B. Drop manhole
 - C. Inverted siphon
 - D. Catch basin

Ans. B

61. A sewer line of diameter 800 mm is to be laid in a colony. The recommended spacing of manholes in straight reaches as per IS 1742 would be:
- A. 45 m
 - B. 75 m
 - C. 90 m
 - D. 120 m

Ans. C

Sol. As per IS 1742:

Size of sewer	Recommended spacing of manholes on straight + Reaches
Dia up to 0.3 m	45 m
upto 0.6 m	75 m
upto 0.9 m	90 m
upto 1.2 m	120 m
upto 1.5 m	250 m
> 1.5 m	300 m

62. Which of the following statements are correct.
- (1) Water pipe is always being laid above the sewer pipe.
 - (2) Cost of construction is high in separate sewerage system than combined sewerage system.
 - (3) Cost of treatment in separate sewerage system is high than combined sewerage system.
- A. 1 & 2 are correct
 - B. 2 and 3 are correct
 - C. 1 and 3 are correct
 - D. 1, 2 and 3 are correct

Ans. A

Sol. Water pipe is being laid above the sewer piper so that if the sewer pipe is laid above water pipe, the organic matter or the polluted water may not get leakage into the water pipe carrying treated water.

There are two separate pipes in the separate sewerage system compared to the one in the combined sewerage system, hence cost of construction is high into the separate sewerage system. The combined sewerage system consists of both the organic matter (sewage) and inorganic matter (drainage). Hence both are removed at the same time, hence cost of treatment is high in combined sewerage system.

63. Sludge bulking can be controlled by:

- | | |
|-----------------|--------------------|
| A. Chlorination | B. Coagulation |
| C. Aeration | D. Denitrification |

Ans. A

Sol. Sludge bulking is caused by filamentous micro-organism and sludge settling characteristics are very poor in this case. It can be controlled by:

- i) Adjusting food to microorganism ratio
- ii) Raising or lowering DO
- iii) Using disinfectant (Chlorine)

The problem of rising sludge is caused by denitrification in the secondary clarifier.

64. Raw water is entering a treatment plant and contains 250 mg/l suspended solids. If 55% of these solids are removed in sedimentation then find the solids removed in sedimentation as sludge?

- | | |
|---------------|---------------|
| A. 144.5 mg/l | B. 141.6 mg/l |
| C. 137.5 mg/l | D. 135.5 mg/l |

Ans. C

Sol. Suspended solids in waste water = 250 mg/l

Since 55% of these solids are removed in sedimentation, we have

The solids removed in sedimentation as sludge = $0.55 \times 250 \text{ mg/l} = 137.5 \text{ mg/l}$

65. A stream ream has flow of 20 cumecs and BOD concentration of 10 mg/l receives the industrial waste water having flow of 1.5 cumecs and BOD concentration of 250 mg/l. What is the BOD concentration (mg/l) of stream at downstream point of meeting of stream with industrial waste?

- | | |
|---------|-----------|
| A. 2.67 | B. 12.0 |
| C. 13 | D. 26 .74 |

Ans. D

Sol.

$$C_{mix} = \frac{C_1\theta_1 + C_2\theta_2}{Q_1 + Q_2} = \frac{20 \times 10 + 1.5 \times 250}{20 + 1.5} = 26.74 \text{ mg/l}$$

66. Which of the following represents a very old lake which has almost become marshy?

- | | |
|-----------------|----------------|
| A. Oligotrophic | B. Mesotrophic |
| C. Eutrophic | D. Senescent |

Ans. D

Sol. Oligotrophic: lake with low level of productivity.

Mesotrophic: lake with medium algal growth.

Eutrophic: lake with high productivity and algal growth.

67. An industrial waste water enters a stream having a BOD concentration of 10 mg/L and a flow of 20 m³/s. If the flow of waste water is 1.5 m³/s and its BOD concentration is 250 mg/L, then the BOD concentration in the stream at a point downstream of the point of confluence of waste water with the stream will be:

- A. 2.67 mg/l
B. 12.09 mg/l
C. 13 mg/l
D. 26.74 mg/l

Ans. D

Sol. $BOD_{stream} = \frac{Q_1 y_1 + Q_2 y_2}{Q_1 + Q_2}$

$$BOD_{stream} = \frac{20 \times 10 + 1.5 \times 250}{20 + 1.5} = 26.74 \text{ mg/l}$$

68. When the recirculation ratio in a high rate trickling filter is unity, then the recirculation factor is:

- A. 1
B. more than 1
C. less than 1
D. zero

Ans. B

Sol. The recirculation ratio

$$\frac{R}{I} = 1$$

then recirculation Factor

$$F = \frac{1 + \frac{R}{I}}{\left(1 + 0.1 \frac{R}{I}\right)^2} = \frac{1 + 1}{(1 + 0.1)^2} = 1.65 > 1$$

69. One litre of sewage, when allowed to settle for 50 minutes gives a sludge volume of 30 cm³. If the dry weight of this sludge is 6 grams, then its sludge volume index is:

- A. 3 ml/gm
B. 5 ml/gm
C. 6 ml/gm
D. 9 ml/gm

Ans. B

Sol. The settled sludge volume $V_{ob} = 30 \text{ cm}^3/\text{lit} = 30 \text{ ml/lit}$

The concentration of suspended solids in mixed liquor $X_{ob} = 6 \text{ gm/lit}$

$$SVI = \frac{V_{ob}}{X_{ob}} = \frac{30}{6} = 5 \text{ ml/gm}$$

70. Select the correct sequence of different phases of biomass curve:

- A. Lag phase → Log growth phase → stationery phase → endogenous phase
B. Lag phase → endogenous phase → stationery phase → log growth phase

78. Calculate the percentage efficiency of BOD removal of an activated sludge treatment plant:

Incoming BOD = 250 mg/l

Outgoing BOD = 20 mg/l

A. 96 %

B. 92 %

C. 88 %

D. 75 %

Ans. B

Sol. Percentage efficiency of BOD removal = $\frac{\text{Incoming BOD} - \text{Outgoing BOD}}{\text{Incoming BOD}} \times 100$

$$\text{Percentage efficiency of BOD removal} = \frac{250 - 20}{250} \times 100 = 92 \%$$

79. Disposal of refuse by Bangalore method involves

A. Aerobic method of composting

B. Anaerobic method of composting

C. Pulverization

D. Pyrolysis

Ans. B

Sol. We have two methods of composting:

C. Bangalore method – anaerobic method

ii. Indore method – aerobic method

80. The disposal method in which solid waste is heated in an oxygen free atmosphere and reduced to gaseous, liquid and solid fractions:

A. Pyrolysis

B. Pulverisation

C. Incineration

D. Composting

Ans. A

Sol. * **Pulverisation:** In this method of refuse disposal, refuse is pulverized in grinding machines, so as to reduce its volume and to change its physical character to make it odourless.

* **Incineration:** Reducing the volume and weight of sludge waste by burning it in a well designed furnace.

* **Composting:** it is a biological method of decomposing sludge waste.

81. A colony generates 73000 m³ of solid waste per annum. The compacted specific weight of solid waste in landfill is 650 kg/m³ and average depth of compacted solid waste in landfill is 5m. Determine the area of landfill required per annum.

A. 1.46 ha

B. 2.12 ha

C. 1.12 ha

D. 3.2 ha

Ans. A

Sol. $\text{Area} = \frac{\text{Volume}}{\text{height}} = \frac{73000}{5} = 14600\text{m}^2 = 1.46 \text{ ha}$

82. Which of the following comes under Rubbish?

A. Vegetable peelings

B. Rags

C. Ashes

D. Excreta

Ans. B

A. 1, 3, 4 only

B. 1, 2, 3 only

C. 2, 3, 4 only

D. 1, 2, 3 and 4

Ans. C

Sol. Primary air pollutants – SO_2 , CO, NO_x , Lead etc

Secondary air pollutants – H_2SO_4 , O_3 , Formaldehyde, PAN etc.

88. Consider the following statements in respect of effect of air pollutants on vegetation:

(i) Necrosis refers to killing of tissue

(ii) Chlorosis refers to loss or reduction of green plant pigment

(iii) Leaf abscission refers to the dropping of leaves

(iv) Leaf epinasty refers to a downward curvature of a leaf due to a higher rate of growth on the upper surface

Which of the above statements are correct?

A. 1, 2 and 3 only

B. 1, 2, 3 and 4

C. 2, 3 and 4 only

D. 1, 2, and 4 only

Ans. B

Sol. Necrosis - death of living tissue specifically death of a portion of tissue differentially affected by local injury

Chlorosis - loss of the normal green coloration of leaves of plants, caused by iron deficiency in lime-rich soils, disease, or lack of light.

Abscission (from the Latin ab, meaning away, and scindere, meaning to cut) is the shedding of various parts of an organism, such as a plant dropping a **leaf**, fruit, flower, or seed.

Leaf epinasty - The downward bending of a **leaf** or other plant part, resulting from greater growth of the upper side than of the lower side.

89. During which of the following operating conditions of an automobile is carbon monoxide content in the exhaust gas the minimum?

A. Idle running

B. Acceleration

C. Cruising

D. Deceleration

Ans. A

Sol. During idle running carbon monoxide level in the exhaust gas is minimum.

90. What is the plume shape during unstable, super-adiabatic atmosphere conditions termed as?

A. Coning plume

B. Fanning plume

C. Looping plume

D. Lofting plume

Ans. C

Sol. Looping plume:

i) High degree of convective turbulence.

ii) Super-adiabatic lapse rate- Strong instability

iii) Associated with the clear daytime- conditions accompanied by strong solar heating and light winds

- A. Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- B. Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
- C. Statement (I) is true but Statement (II) is false
- D. Statement (I) is false but Statement (II) is true

Ans. A

Sol. CO has 230 times more affinity with hemoglobin than the oxygen. Because of this hemoglobin reacts with CO and not with Oxygen. Hemoglobin is responsible for supplying oxygen in our body.

95. Acceptable noise level in dB for auditorium is:
- A. 25 to 30
 - B. 40 to 45
 - C. 35 to 40
 - D. 45 to 55

Ans. C

Sol. According IS code recommendations acceptable noise level in dB based on location are as follow:

1.	Radio and TV studios	25-35
2.	Music rooms	30-35
3.	Hospital and classroom auditorium/small office	35-45
4.	Large public office/banks	45-50
5.	Restaurants	50-65

96. According to ambient air quality standard in respect of noise (MOEF) mention noise limits for silence zone in day time
- A. 40 dB (A) Leq
 - B. 45 dB (A) Leq
 - C. 50 dB (A) Leq
 - D. 75 dB (A) Leq

Ans. C

Sol. Acceptable noise level is 50 dB for silence zone in day time.

97. Electrostatic precipitators are used for removal of:
- 1) Gaseous contaminants
 - 2) Liquid contaminates
 - 3) Particulate contaminates
- A. 1 only
 - B. 2 only
 - C. 3 only
 - D. 1, 2 and 3

Ans. D

Sol. Electrostatic precipitators are used to remove the solid and liquid contaminants from the flowing gases.

98. The principle involved in collection and sampling of particulate matter in which the particles are drawn through a devices by defecting them for their original paths is called
- A. Filtration
 - B. Electrostatic precipitation
 - C. Impaction
 - D. Gravitational settling

Ans. B

Sol. In electrostatic precipitators, the emitted gas is passed through a highly ionized atmosphere i.e. in high voltage field, and in the that zone particulates get electrically charged with the result that they got separated out form the gaseous stream with the help of electrostatic forces.

99. Consider the following statements regarding pyrolysis:

- 1) It is an irreversible chemical change brought about by the action of heat in oxygen-free atmosphere.
- 2) Range of temperature is 500 °C to 1000 °C
- 3) Internal heating causes organic matter to decompose physically and chemically rather than burn.
- 4) It is a highly exothermic process.

Which of the above statements are correct?

- | | |
|------------------|--------------------|
| A. 1, 2, 3 and 4 | B. 1, 3 and 4 only |
| C. 2 and 4 only | D. 1, 2 and 3 only |

Ans. D

Sol. Pyrolysis is chemical change brought about by the action of heat in oxygen free atmosphere which is irreversible and endothermic occurring in the temperature range of 500 °C to 1000 °C

Since it occurs in absence of oxygen, an internal heating makes organic matter to decompose rather than get burnt.

100. Which one of the following statements is correct?

- A. Combustion is an endothermic process, which takes place in the abundance of oxygen.
- B. Combustion is an exothermic process, which takes place in the absence of oxygen.
- C. Pyrolysis is an endothermic process, which takes place in the absence of oxygen.
- D. Pyrolysis is an exothermic process, which takes place in the absence of oxygen.

Ans. C

Sol. Pyrolysis is an endothermic process, which takes place in the absence of oxygen.
