Waste Water Engineering Test 2

Number of Questions: 25 **Time: 60 min.**

Directions for questions 1 to 25: Select the correct alternative from the given choices.

1. Maximum runoff will be obtained from the rain having a duration equal to time of concentration, and this is called the
(A) Point rainfall intensity
(B) Time of equilibrium
(C) One hour rainfall
(D) Critical rainfall duration

2. A well oxidized sewage will contain
(A) Nitrites and sulphur
(B) More Ammonia and H_2S but less nitrates and sulphates
(C) Less Ammonia and H_2S but more nitrates and sulphates
(D) H_2S, CO_2 and water

3. Particles whose size is greater than 1 μm are
(A) Colloidal solids (B) Suspended solids
(C) Settleable solids (D) Dissolved solids

4. In determination of Chemical Oxygen Demand, sewage is titrated with ferrous ammonium sulphate using potassium dichromate as oxidant in the presence of silver sulphate and mercuric sulphate as catalyst and inhibitor respectively. In this the excess amount of _______ left in sample after digestion is found.
(A) Potassium dichromate
(B) Ferrous Ammonium sulphate
(C) Mercuric Sulphate
(D) Oxygen

5. The degree and amount of treatment given to raw sewage before disposing off into river stream will depend upon
1. Quantity of raw sewage only
2. Self purification capacity of river stream
3. Intended use of its water
(A) 1, 3 (B) 2 only
(C) 1, 2, 3 (D) 1 only

6. Preliminary treatment reduce the BOD of the waste water by
(A) 5 – 10% (B) 10 – 20%
(C) 15 – 30% (D) 25 – 40%

7. The girt chambers of a sewage treatment plant normally need cleaning
(A) Every hour (B) Every day
(C) Every fortnight (D) Every year

8. Activated sludge treatment plants are normally preferred for
(A) Large sized cities
(B) Towns and smaller cities
(C) Medium sized cities
(D) All of them

9. Prechlorination of sewage before it enters the sedimentation tank may help in
1. Controlling odour
2. Prevent flies in trickling filter
3. Assist in removal of grease
4. Reduce bacterial count
(A) 1 and 4 (B) 1, 2, 3 only
(C) 2, 3, 4 only (D) All of the above

10. In the final stage of sludge digestion, more resistant materials like proteins and organic acids are attacked and broken up by anaerobic bacteria called
(A) Acid formers (B) Suspended culture
(C) Mesophilic organisms (D) Methane formers

11. A river with a flow of 0.25 m^3/s receives waste water at a rate of 0.1 m^3/s. River has 8 mg/l of DO with no BOD. The waste water with BOD 30 mg/l having no DO disposed into it. If deoxygenating and reoxygenation constant are 0.36 d^{-1} and 0.7 d^{-1} respectively. Find the critical deficit (D_C) and distance at which it occurs on D/s of disposal of waste water?
Assume $(DO)_{saturation}$ = 9 mg/l and velocity of flow in river = 0.4 m/s.
(A) D_C = 3.825 mg/l at 30.96 km
(B) D_C = 3.4 mg/l at 5 km
(C) D_C = 3.29 mg/l at 30 km
(D) D_C = 2.8 mg/l at 15 km

12. In a community of 1500 people water is supplied at 200 l/head/day. If BOD produced is 40 g/head/day and BOD loading rate for oxidation pond is 20 kg/ha/day. (Assume depth of pond, d = 2 m and efficiency of pond as 80%).
Find the BOD of the effluent and whether it can be used for irrigation?
(A) 100 mg/l and suitable for irrigation
(B) 150 mg/l and not suitable for irrigation
(C) 75 mg/l and not suitable for irrigation
(D) 50 mg/l and suitable for irrigation

13. Following data pertaining to Activated sludge process is given below:
Flow rate Q = 12,000 m^3/day
BOD of influent y_i = 280 mg/l
BOD of effluent y_e = 30 mg/l
X: MLSS concentration = 3000 mg/l
X_u: MLSS in underflow = 10,000 mg/l
X_e: MLSS in effluent = 0
If = $\frac{F}{M}$ 0.3 day^{-1} and θ_C = 12 days. Find mass of solids wasted in kg/day?

(A) 1000 (B) 1120
(C) 1500 (D) 800

14. Find out the Theoretical Oxygen Demand (in mg/l) for glucose of 300 mg/lpresent in waste waters if the following chemical reaction is given

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

(A) 320 (B) 420
(C) 120 (D) 220

15. A population of 20,000 is residing in a town having an area of 60 hectares. Water supply per capita is 120 lt/day. If the average runoff coefficient of the area is 0.5 and time of concentration of design rain is 30 minutes, Calculate the discharge for which the sewers of a proposed combined system will be designed for the town? [Use rational method for runoff. Assume 80% of water supply as wastage and maximum sewage discharge as 3 × (Average discharge)]

(A) 1.67 m^3/s (B) 2.1 m^3/s
(C) 1.74 m^3/s (D) 0.06 m^3/s

16. Match List – I with List – II and select the correct answer using the code given below.

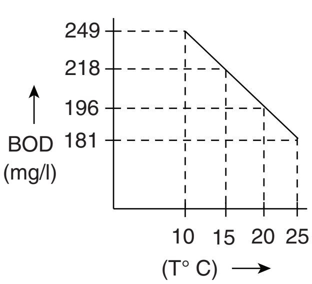
	List – I (Process)		List – II (Biological agent)
a.	Oxidation ditch	1.	Facultative bacteria
b.	Waste water stabilization	2.	Anaerobic bacteria
c.	Imhoff tank	3.	Suspended Culture (Aerobic bacteria)
d.	Rotating Biological Contactors (RBC)	4.	Attached Culture (Aerobic bacteria)

	a b c d		a b c d
(A)	4 1 2 3	(B)	3 1 2 4
(C)	1 2 3 4	(D)	3 4 1 2

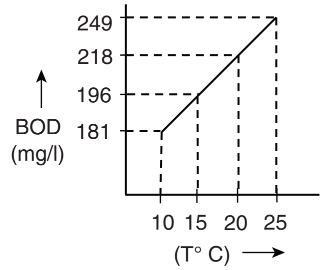
17. The sewage is flowing at 5 MLD from a primary clarifer to a standard rate trickling filter. The $y_5^{20°C}$ = 180 mg/l. The value of the adopted organic loading is to be 150 gm/m^3/day and surface loading 1500 l/m^2/day. Calculate the efficiency of this filter unit.

(A) 85.44% (B) 78.51%
(C) 80.03% (D) 69.91%

18. The 3 day 20°C BOD of a sample of sewage is 200 mg/l. Draw a graph of 5 day BOD as a function of temperature in the range, 10°C to 25°C in steps of 5°C. Assume K_D at 20°C = 0.1



(A)



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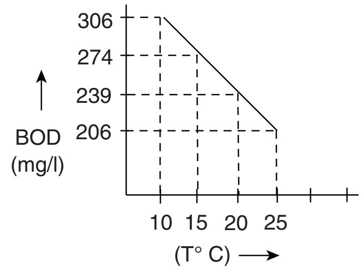
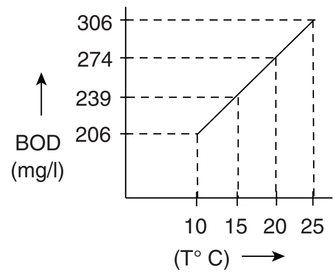


(C)



(D)

Common Data for Questions 19 and 20:

A completely mixed activated sludge process is used to treat a waste water flow of 2 MLD having a BOD at 5 days as 250 g/l. The biomass concentration of aeration tank is 2100 mg/l and the concentration of the net biomass leaving the system is 50 mg/l. The aeration tank has a volume of 250 m^3.

19. What is the hydraulic retention time of the waste water in aeration tank? (in hours)

(A) 1 (B) 3
(C) 9 (D) 12

20. What is the average time for which the biomass stays in the system?

(A) 3.18 hours (B) 4.61 days
(C) 5.25 days (D) 8.21 hours

21. Match Column – I with Column – II

	Column – I		Column – II
P.	Grit Chamber	1.	Zone settling
Q.	Secondary settling tank	2.	Stoke's law
R.	Activated sludge process	3.	Aerobic process
S.	Trickling filter	4.	Contact stabilization

	P Q R S		P Q R S
(A)	1 2 3 4	(B)	2 1 3 4
(C)	1 2 4 3	(D)	2 1 4 3

22. Statement I: Nitrates are non-objectionable end products in aerobic treatment of sewage.
Statement II: Nitrates > 45 ppm cause nitrate poisoning in infants.
(A) I is true and II is false
(B) I is false and II is true
(C) Both I and II are true
(D) Both Iand II are false

23. A sewer has a diameter of 250 mm and slope of 1 in 500. While running full it has a mean velocity of 0.8 m/s. If both diameter and slope are doubled, what will be the changed mean velocity when running half full? (Use Manning's formula)
(A) 1.0 m/s (B) 1.2 m/s
(C) 1.6 m/s (D) 1.8 m/s

24. A combined sewer is serving 30,000 persons having BOD 80 gm per capita for day and 60,000 liters industrial effluent per day having BOD 500 mg/l. If average standard BOD of domestic sewage is 0.09 kg/day/person. Find the population equivalent of sewage
(A) 27,000 (B) 20,000
(C) 22,000 (D) 25,000

25. Match List – I with List – II

	List – I (Empirical Formula)		**List – II (Catchments)**
P.	Inglis formula	1.	North India
Q.	Ryve's formula	2.	South India
R.	Nawab Jung Bahadur formula	3.	Old Bombay State
S.	Burge's formula	4.	Hyderabad Deccan
		5.	Based on Indian records

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

Answer Keys

1. D	**2.** C	**3.** B	**4.** A	**5.** C	**6.** C	**7.** C	**8.** A	**9.** B	**10.** D
11. A	**12.** D	**13.** B	**14.** A	**15.** C	**16.** B	**17.** A	**18.** D	**19.** B	**20.** C
21. B	**22.** C	**23.** D	**24.** A	**25.** D					

Hints and Explanations

2. Free ammonia, H_2s and nitrites indicate initial stages of decomposition. Nitrites and sulphates indicates fully oxidized sewage Choice (C)

3.
$$\begin{bmatrix} \text{Pariticlessize } > 10\ \mu_m \Rightarrow \text{settleable solids.} \\ > 1\ \mu_m \Rightarrow \text{suspended solids.} \\ 1-10^{-3}\ \mu_m \Rightarrow \text{Colloidals solids.} \\ < 10^{-3}\ \mu_m \Rightarrow \text{dissolved solids.} \end{bmatrix}$$

Choice (B)

7. Grit chambers of a sewage treatment plant are cleaned every fort night Choice (C)

8. Activated sludge treatment plants are prepared large sized cities as they are costly. Choice (A)

9. Prechlorination helps for first three whereas Post chlorination helps for reducing bacterial count and BOD. Choice (B)

10. In Acid Fermentation (1st stage) sewage is acted upon by acid formers. In Alkaline Fermentation (3rd stage) sewage is acted upon by methane formers. Choice (D)

11.

River	Waste water
Q_R: 0.25 m³/s	Q_W = 0.1 m³/s
$(DO)_R$: 8 mg/l	$(DO)_W = 0$
y_R : 0	y_w : 30 mg/l

$K_1 = 0.36\ d^{-1}$
$K_2 = 0.7\ d^{-1}$

$$y_{mix} = \frac{(0+0.1\times 30)}{(0.25+0.1)} = 8.57 \text{ mg/l}$$

$$(DO)_{mix} = \frac{0.25\times 8}{0.25+0.1} = 5.71 \text{ mg/l}$$

$$D_O = (DO)_{sat} - (DO)_{mix}$$
$$= 9 - 5.71 = 3.29 \text{ mg/l}$$

$$y_{mix} = L_o\left[1-e^{-k_1 t}\right]$$

$$8.57 = L_o\left[1-e^{-0.36\times 5}\right]$$

$$\Rightarrow \quad L_o = 10.27 \text{ mg/l}$$

Critical time

$$t_c = \frac{1}{K_2-K_1}\ln\left[\frac{K_2}{K_1}\left(1-D_o.\frac{K_2-K_1}{K_1 L_0}\right)\right]$$

$$= \frac{1}{0.7-0.36}\ln\left[\frac{0.7}{0.36}\left(1-3.29\times\frac{(0.7-0.36)}{0.36\times 10.27}\right)\right]$$

= 0.896 days

Critical deficit: $D_C = \frac{K_1}{K_2} L_o e^{-k_1 t_c}$

$$= \frac{0.36}{0.7}\times 10.27\ e^{-0.36\times 0.896}$$

= 3.825 mg/l

Velocity flow in river $V = 0.4$ m/s
Distance at which critical flow occurs
$= 0.4 \times 0.896 \times 24 \times 60 \times 60$
$= 30.96 \times 10^3$ m
$= 30.96$ km. Choice (A)

12. Population = 1500
Water supplied = 200 l/head/day
80% of water is converted to waste water
$Q_w = 1500 \times 200 \times 0.8 = 24 \times 10^4$ l/day
$= 240$ m^3/day $= 0.24$ MLD
Total BOD produced = 1500×40
$= 60 \times 10^3$g/day
$= 60$ kg/day
Total BOD applied = Qy_i
60×10^6mg/day $= 0.24 \times 10^6$l/day $\times y_i$
$y_i = 250$ mg/l
$\eta = 80\%$
$$80 = \frac{250 - y_e}{250} \times 100$$
$y_e = 50$ mg/l ≤ 100 mg/l which is the limitation value for irrigation
$\therefore$ Effluent water is suitable for Irrigation. Choice (D)

13. We know,
$$\frac{F}{M} = \frac{Qy_i}{VX}$$
$$0.25 = \frac{12{,}000 \times 280}{V \times 3000}$$
$V = 4480$ m^3
$$\theta_c = \frac{\text{Mass of solids in aeration}}{\text{Mass of solids wasted/day}}$$
$$12 = \frac{VX}{Q_w X_u + Q_e X_e}$$
$$Q_w X_u = \frac{4480 \times 10^3 \times 3000}{12} \quad [\because 1\text{m}^3 = 1000 \text{ L and } X_e = 0]$$
$= 1.12 \times 10^9$ mg/day
$= 1120$ kg/day. Choice (B)

14. Mol. Wt of $C_6H_{12}O_6$ (Glucose)
$= (6 \times 12) + (12 \times 1) + (6 \times 16) = 180$
Mol. wt of $6O_2 = 6[2 \times 16] = 192$
180 parts of glucose demand: 192 parts of O_2
1 part glucose demand $= \frac{192}{180}$ parts of O_2
300 mg/l of glucose demand $= \frac{192}{180} \times 300$
$= 320$ mg/l of O_2
$\therefore$ TOD = 320 mg/l. Choice (A)

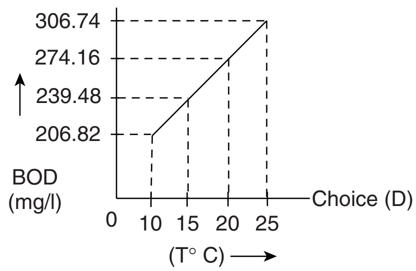
15. Quantity of sanitary sewage produced per day
$$= \left(\frac{80}{100}\right) \times 120 \times 20000 = 1.92 \times 10^6 \text{ltrs.}$$
Quantity of sewage produced per second
$$= \frac{1920}{24 \times 60 \times 60} = 0.022 \text{ cumecs}$$
Maximum sewage discharge = 3×0.022
$Q_s = 0.066$ cumecs
Storm water discharge by Rational Method
$$Q_R = \frac{KP_C A}{36}$$
$$\left[\begin{array}{l} P_C = \dfrac{a}{t_c + b} \text{cm/hr} \\ \text{as } t_c \ge 20 \text{minutes} \\ \qquad a = 100; b = 20 \end{array}\right]$$
$$P_C = \frac{100}{30 + 20} = 2\text{cm/hr}$$
$$Q_R = \frac{1}{36} \times 0.5 \times 2 \times 60$$
$= 1.67$ cumecs
Total peak discharge $= Q_s + Q_R = 0.066 + 1.67$
$= 1.736$ cumecs. Choice (C)

17. Efficiency $\eta = \dfrac{100}{1 + 0.0044\sqrt{u}}$
u = organic loading in kg/ha–m/day
$u = 150$ gm/m^3/day
1 hectare $= 10^4$m^2
$u = 150 \times 10^4$gm/ha–m/day
$= 1500$ kg/ha–m/day
$$\eta = \frac{100}{1 + 0.0044\sqrt{1500}}$$
$= 85.44\%$. Choice (A)

18. $y_3^{20°C} = L\left[1 - (10)^{-K_D \times t}\right]$
$200 = L[1 - (10)^{-0.1\times3}]$
$L = 400.95$ mg/l
$$K_{D(10°C)} = K_{D(20°C)}[1.047]^{T-20°C}$$
$= 0.1[1.047]^{10-20}$
$= 0.063$
$K_{D(15°C)} = 0.1[1.047]^{15-20} = 0.079$
$K_{D(25°C)} = 0.1[1.047]^{25-20} = 0.1258$
$y_5^{10°C} = 400.95[1 - 10^{-0.063\times5}]$
$= 206.82$ mg/l
$y_5^{15°C} = 400.95[1 - 10^{-0.079\times5}]$
$= 239.48$ mg/l
$y_5^{20°C} = 400.95[1 - 10^{-0.1\times5}]$s
$= 274.16$ mg/l

$y_5^{25^o C} = 400.95\ [1 - 10^{-0.1258\times5}]$

$= 306.74$ mg/l



Choice (D)

19. $Q = 2 \times 10^6$ lit/day
$y_i = 250$ mg/l
$X = 2100$ mg/l
$X_e = 50$ mg/l
$V = 250\ m^3 = 250 \times 10^3$ lit

$$HRT = \frac{V}{Q} = \frac{250\times10^3}{2\times10^6}$$

$= 0.125$ days $= 3$ hours. Choice (B)

20. $$\theta_C = \frac{VX}{Q_w X_w + Q_e X_e}$$

Neglecting X_w (being small and not given)

$$Q_C = \frac{250\times10^3\times2100}{2\times10^6\times50}$$

$= 5.25$ days. Choice (C)

22. Statement I and II seems to be contradicting.
In infants there exists lower acidity in intestines which permits growth of nitrate reducing bacteria, which convert nitrate to nitrites. Nitrates' having great affinity for haemoglobin than oxygen and cause suffocation and body turns blue called blue baby disease or mathaemoglobinemia. This is only in children <6 months.
Choice (C)

23. $$V = \frac{1}{N} R^{2/3} S^{1/2}$$

Hydraulic mean depth $R = \dfrac{D}{4}$

$$\frac{V_1}{V_2} = \frac{R_1^{2/3} S_1^{1/2}}{R_2^{2/3} S_2^{1/2}}$$

$$R_1 = \frac{D_1}{4}$$

$R_2 = \dfrac{D_2}{4} = \dfrac{2D_1}{4}$ [though running half/full $R = \dfrac{D}{4}$]

$$S_1 = \frac{1}{500}$$

$$S_2 = \frac{1}{250}$$

$$\frac{0.8}{V_2} = \frac{R_1^{2/3}}{(2R_1)^{2/3}} \times \frac{\left(\frac{1}{500}\right)^{1/2}}{\left(\frac{1}{250}\right)^{1/2}}$$

$V_2 = 1.795$ m/s
$\simeq 1.8$ m/s. Choice (D)

24. (i) BOD of sewage produced per day
$= 30000 \times 80 = 2400 \times 10^3$ gm/day
$= 2400$ kg/day
(ii) BOD of industrial effluent per day
$= 60000 \times 500$
$= 30 \times 10^6$ mg/day
$= 30$ kg/day
Total BOD entering the sewer
$=$ (i) + (ii)
$= 2430$ kg/day
Population equivalent

$$= \frac{\text{Total BOD}}{\text{Standard BOD of domestic sewage}}$$

$$= \frac{2430}{0.09} = 27000.$$ Choice (A)