CLASS TEST

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Environment Engineering

CIVIL ENGINEERING

Date of Test : 26/08/2026

ANSWER KEY

1.	(d)	7.	(b)	13.	(a)	19.	(b)	25.	(b)
2.	(a)	8.	(c)	14.	(b)	20.	(a)	26.	(c)
3.	(b)	9.	(d)	15.	(b)	21.	(d)	27.	(b)
4.	(a)	10.	(b)	16.	(a)	22.	(a)	28.	(a)
5.	(d)	11.	(c)	17.	(c)	23.	(d)	29.	(a)
6.	(c)	12.	(d)	18.	(c)	24.	(d)	30.	(b)

DETAILED EXPLANATIONS

1. (d)

2. (a)

3. (b)

4. (a)

Given:
$$TH = 200 \text{ mg/L as } CaCO_3$$
$$\text{Alkalinity} = 260 \text{ mg/L as } CaCO_3$$

$\therefore$ Carbonate hardness
$$CH = \text{minimum (TH, alkalinity)}$$
$$= 200 \text{ mg/L as } CaCO_3$$
$$\Rightarrow \quad NCH = 0$$

5. (d)

Sludge volume index,
$$SVI = \frac{200}{\left(\frac{4000}{1000}\right)} = 50 \text{ m}l\text{/gm}$$

6. (c)

7. (b)

Total hardness

TH(in mg/l as $CaCO_3$) = (milli. eq. of Ca^{2+}) $\times$ eq. wt. of $CaCO_3$ + (milli. eq. of Mg^{2+}) $\times$ eq. wt of $CaCO_3$
$$= 40 \times 50 + 20 \times 50 = 3000$$
$$\therefore \quad TH > \text{Alkalinity}$$
$$\therefore \quad CH = \text{Alkalinity} = 2250 \text{ mg/}l \text{ as } CaCO_3$$
$$\therefore \quad NCH = 3000 - 2250 = 750 \text{ mg/}l \text{ as } CaCO_3$$

8. (c)

9. (d)

10. (b)

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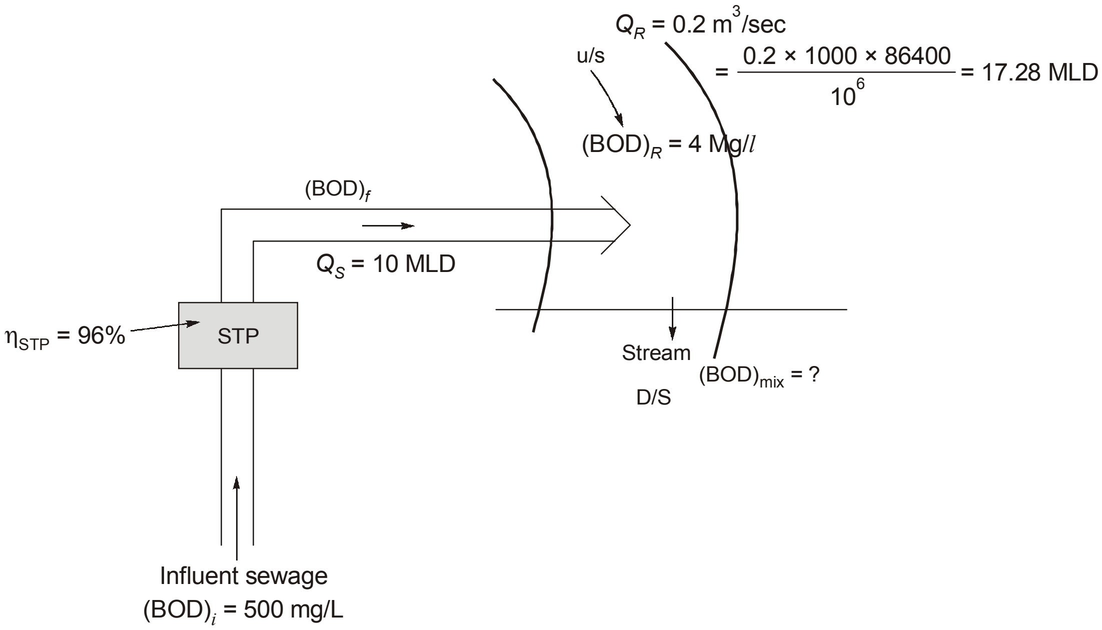
11. (c)

Given, as per question



$$Q_s = 10 \text{ MLD}$$

$$(\text{BOD})_i = 500 \text{ mg}/l$$

$$\eta_{STP} = \frac{(\text{BOD})_i - (\text{BOD})_f}{(\text{BOD})_i} \times 100$$

$$96 = \frac{500 - (\text{BOD})_f}{500} \times 100$$

$$(\text{BOD})_f = 20 \text{ mg}/l$$

BOD of stream on D/S

i.e. $$(\text{BOD})_{mix} = \frac{Q_S \times (\text{BOD})_S + Q_R \times (\text{BOD})_R}{Q_R + Q_S}$$

$$= \frac{10 \times 20 + 17.28 \times 4}{17.28 + 10} = 9.865 \simeq 9.87 \text{ mg}/l$$

12. (d)

Combined sewer is designed for maximum sewage discharge and the maximum runnoff discharge and the maximum run off discharge under designed condition, sewer is assumed to be run full.

$\therefore$ $$Q_{s,(peak)} = 3 \times Q_{DWF}$$

$$= 3\,(50{,}000 \times 135 \times 0.75) = 15187500 \text{ lit/day}$$

$$= \frac{15187500 \times 10^{-3}}{86400} = 0.175 \text{ m}^3/\text{sec}$$

Storm water peak flow rate (i.e. maximum runoff discharge)

$$Q_{runoff(paek)} = \frac{1}{36} P_c\, k.A$$

$$A \text{ (in ha)} = 80 \text{ ha}$$

$$P_c \text{ (in cm/hr)} = 1.6 \text{ cm/hr}$$

$$k = 0.7$$

$$Q_{R,(peak)} = \frac{1}{36} \times 0.7 \times 1.6 \times 80 = 2.488 \text{ m}^3\text{/sec}$$

$$\therefore \quad Q_{design} = Q_{S\,(peak)} + Q_{R\,(peak)} = 0.175 + 2.488 = 2.663 \simeq 2.66 \text{ m}^3\text{/sec}$$

13. (a)

From Manning's formula

As we know that

$$v = \frac{1}{n}.R^{2/3}.s^{1/2}$$

Case-I

$$\text{diameter} = 300 \text{ mm}$$

$$\text{slope} = \frac{1}{400}$$

Flowing full,

$$R = \frac{D}{4}$$

$$v = 0.7 \text{ m/sec}$$

$$v = \frac{1}{n}\left(\frac{D}{4}\right)^{2/3}.(s)^{1/2}$$

$$v = \frac{1}{n}\left(\frac{300}{4}\right)^{2/3}.\left(\frac{1}{400}\right)^{1/2} = 0.7 \quad \text{...(i)}$$

Case-II

$$\text{diameter} = 600 \text{ mm}$$

$$\text{slope} = \frac{1}{200}$$

Flowing half full,

$$R = \frac{D}{4} \quad \text{(for half full)}$$

$$v = \frac{1}{n}\left(\frac{600}{4}\right)^{2/3}\left(\frac{1}{200}\right)^{1/2} \quad \text{...(ii)}$$

By solving equation (i) and (ii)

$$\frac{v}{0.7} = \frac{(150)^{2/3}\left(\frac{1}{200}\right)^{1/2}}{(75)^{2/3}\left(\frac{1}{400}\right)^{1/2}}$$

$$v = 1.57 \text{ m/sec}$$

14. (b)

$$1\ \mu\text{g/m}^3 = \frac{\text{ppm} \times \text{mol.wt.} \times 10^3}{\text{volume of T°C (in lit/mol)}}$$

$$V_2 = V_1\left(\frac{273 + T_2}{273}\right)$$

$T_1 = 0°\text{C}$, $V_1 = 22.4$ lit/mol, $T_2 = 25°\text{C}$

$$V_2 = 22.4\left(\frac{273 + 25}{273}\right) = 24.45 \text{ lit/mol}$$

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$$\text{CO (in ppm)} = 9$$
$$\text{Mol. wt. of CO} = 28 \text{ gm}$$
$$\therefore \quad \text{CO } (\mu g/m^3) = \frac{9 \times 28 \times 1000}{24.45} = 10306.74 \simeq 10307$$

15. (b)

Energy (ash) free dry basis

$$= \text{Energy (as discarded)} \times \frac{100}{100 - \%\text{ash} - \%\text{m.c}}$$
$$= 12000 \times \frac{100}{100 - 4 - 18} = 15384.62 \text{ kJ/kg}$$

16. (a)

$$\text{Molecular weight of glumatic acid} = 5 \times 12 + 9 \times 1 + 4 \times 16 + 14 = 147 \text{ gm}$$
$$\text{Total oxygen used in the reaction} = 6.5 \times 32 = 208 \text{ gm}$$

$\therefore$ 147 gm of glumatic acid requires 208 gm of oxygen

$$\text{ThoD} = 63 \times \frac{208}{147} = 89.14 \text{ mg}/l \simeq 89 \text{ mg}/l$$

17. (c)

Catabolic reactions are those in which food is broken down to release energy.

The end products of aerobic catabolism are low-energy, stable compounds with most of the energy being stored in cellular material.

18. (c)

1. Anaerobic reactions are more complex because they occur in two stages carried out by different species of bacteria.
2. Acid forming bacteria initially convert complex organics into organic acids and alcohols.
3. The end product of anaerobic reactions still contain considerable amount of energy, notably in methane.

19. (b)

$$TH_{(\text{in mg}/l \text{ as } CaCO_3)} = Ca^{2+} \times \frac{50}{20} + Mg^{2+} \times \frac{50}{12} + Sr^{2+} \times \frac{50}{43.8}$$
$$T_H = 180 = x \times \frac{50}{20} x \times \frac{50}{12} + x \times \frac{50}{43.8}$$
$$x = 23.05 \text{ mg/lit}$$

20. (a)

Chloro-organics and chloramines are get destructed and bad smell suddenly disappears. Any further chlorine addition simply appears are free chlorine. This point is called break point.

21. (d)

$$L_{eq} = 10 \log . \Sigma\, 10^{Li/10} \times t_i$$
$$= 10 \log\left[10^{50/10} \times \frac{55}{60} + 10^{90/10} \times \frac{5}{60}\right]$$
$$= 79.2 \text{ dB}$$

22. (a)

Given,
$$(BOD)_{5day} = 150 \text{ mg}/l \text{ at } 20°C$$
$$k(\text{base } 10) = 0.2 \text{ d}^{-1}$$
$$\text{To find } (BOD)_{8day} = ? \text{ at } 15°C$$
$$\text{Temperature coefficient} = 1.145$$
$$Y_5 = l_0(1 - 10^{-K_D t})$$
$$50 = l_0(1 - 10^{-0.2\times5})$$
$$l_0 = \frac{150}{1-10^{-1}} = 166.67 \text{ mg/lit}$$
$$K_{D(T=15°C)} = K_{D(T=20°C)}(1.145)^{T-20}$$
$$= 0.2(1.145)^{15-20} = 0.1016 \text{ d}^{-1}$$

8 day BOD

$$\therefore \quad Y_8 = l_0(1 - 10^{-K_D\times8})$$
$$= 166.67(1 - 10^{-0.1016\times8}) = 141.03 \text{ mg/lit}$$

23. (d)

- Fluorides are removed with aluminum oxide.
- Hexavalent chromium can be removed by reduction and followed by precipitation.
- Iron and manganese can be removed by aeration followed by coagulations, sedimentation and filtration.
- Toxic organics can be removed by activated carbon treatment.

24. (d)

$$\text{BOD loading rate} = 250 \text{ kg/ha/day}$$

Waste water flow
$$Q = 1 \text{ MLD with BOD} = 250 \text{ mg/lit}$$
$$\therefore \quad \text{Surface area of pond} = \frac{\text{BOD applied}}{\text{BOD loading rate}}$$
$$\therefore \quad \text{Surface area of pond} = \frac{(1\times250)\text{ kg/day}}{250 \text{ kg/ha/day}} = 1 \text{ ha} \qquad (\text{MLD} \times \text{mg}/l = \text{kg/day})$$
$$\therefore \quad \text{Volume of pond } (V) = \text{Surface area} \times \text{depth} = 1 \text{ ha} \times 1 = 10^4 \times 1 = 10^4 \text{ m}^3$$
$$\therefore \quad \text{Detention time } (D_t) = \frac{V}{Q} = \frac{10^4}{\left(\frac{1\times10^6}{10^3}\right)} = 10 \text{ days}$$

25. (b)

General equation of kinetics is
$$\frac{dC_A}{dt} = -kC_A^n$$

Order = 2
$$\therefore \quad \int_{C_o}^{C_t} \frac{dC_A}{C_A^2} = \int_o^t -kdt$$
$$\Rightarrow \quad \left(\frac{1}{C_o} - \frac{1}{C_t}\right) = -kt$$

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Given, $C_o = 0.25$ mg/l, $k = 0.5$ per day, $t = 2$ days

$$\Rightarrow \qquad \frac{1}{C_t} = \frac{1}{0.25} + 1$$

$$\Rightarrow \qquad C_t = 0.2 \text{ mg}/l$$

26. (c)

1. Circular sewer section are mostly used for separate sewage system. But the advantage of circular sewer is obtained only when the section runs atleast half full.
2. If a circular sewer is used for combined system. It will be effective only during maximum rain water flow, but during dry weather flow, velocity generated would be very less.

27. (b)

Nitrogen in any soluble from i.e. NH_3, NH_4^+, NO_2^- and NO_3^- excluding N_2 gas is a nutrient and may need to be removed from waste water to help control algal growth in the receiving body.

28. (a)

Year	Population	Increase in population	%age inc.
1971	8,00,000	—	
1981	9,50,000	150000	$\frac{150000}{800000} \times 100 = 18.75\ (r_1)$
1991	11,20,000	170000	$\frac{170000}{950000} \times 100 = 17.89\ (r_2)$
2001	13,45,000	225000	$\frac{225000}{1120000} \times 100 = 20.09\ (r_3)$

∴ Average %age increase,

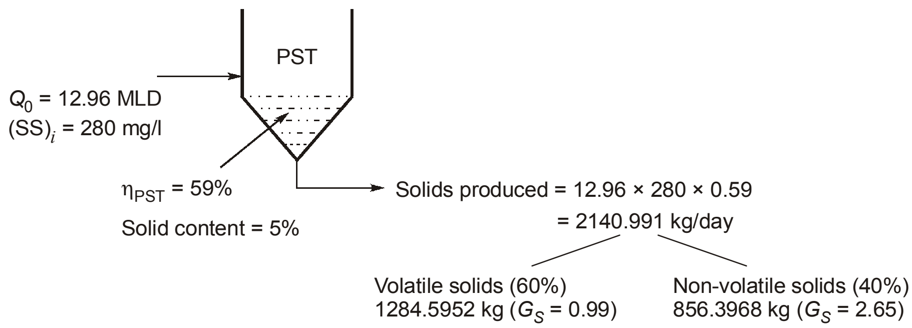
$$r = (r_1 r_2 r_3)^{1/3} = (18.75 \times 17.89 \times 20.09)^{1/3}$$
$$= 18.89\%$$

Population at the end of 2031 i.e. after 3-decades. As by geometrical increase method, we know that

$$P_n = P_0\left(1 + \frac{r}{100}\right)^n$$

$$P_2 = 13{,}45{,}000\left(1 + \frac{18.89}{100}\right)^3 = 2260259$$

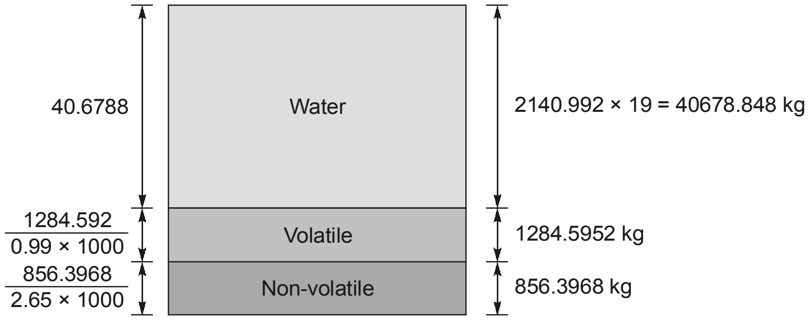
29. (a)



5 kg of solids $\simeq$ 100 kg of sludge

or, 5 kg of solids $\cong$ 95 kg of water

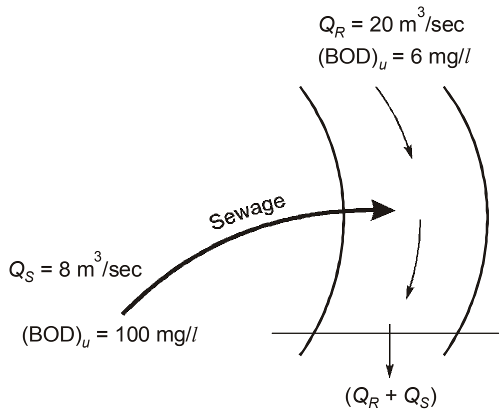
1 kg of solids $\cong$ 19 kg of water



$\therefore$ Daily sludge volume production $= \left(40.6788 + \frac{1284.592}{0.99 \times 1000} + \frac{856.3968}{2.65 \times 1000}\right)$

$= 42.299 \simeq 42 \text{ m}^3$

30. (b)



Given, Cross section area of river $= 80 \text{ m}^2$

$\therefore$ Velocity of river after mixing $V = \frac{(20+8)}{80} = 0.35$ m/sec

$$(\text{BOD})_{u,\,\text{mix}} = \frac{Q_S(\text{BOD})_{uS} + (Q_R) \times (\text{BOD})_{uR}}{Q_S + Q_R}$$

$$(\text{BOD})_{u,\,\text{mix}} = \frac{8 \times 100 + 20 \times 6}{8 + 20} = 32.86 \text{ mg}/l$$

Also, given BOD remaining in the river = 5 mg/l

$$l_t = l_0 \, e^{-kt}$$

$$5 = 32.86 \, e^{-0.252 \times t}$$

$$t = 7.47 \text{ days}$$

$\therefore$ Distance after which BOD remaining (= 5 mg/l)

$$S = Vt = \frac{0.35 \times 7.47 \times 86400}{1000} \text{ km} = 225.94 \text{ km}$$

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