CLASS TEST

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Environment Engineering

CIVIL ENGINEERING

Date of Test : 06/09/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)

Nitrite : Color induced by addition of sulphonic acid and napthamine.
Nitrate: Color induced by addition of phenol di-sulphonic acid and KOH.
Fluoride: Color induced by addition of zirconium and alizarine.

2. (c)

According to national board of fire under writers formula,

$$F_D = 4637\sqrt{P}\left(1-0.01\sqrt{P}\right) l/\text{min} \qquad \text{(where } P \text{ is in thousand)}$$

$$= 4637\sqrt{200}\left(1-0.01\sqrt{200}\right) = 56303\, l/\text{min}$$

$$= \frac{56303}{10^3 \times 60} = 0.938 \text{ m}^3/\text{s}$$

3. (d)

$$\text{Alkalinity} = \frac{500}{2} \text{ mg}/l = 250 \text{ mg}/l$$

$$\text{Hardness} = \frac{450}{2} \text{ mg}/l = 225 \text{ mg}/l$$

Carbonate hardness = min. {Alkalinity, Hardness}
= 225 mg/l

Non-carbonate hardness = Hardness – Carbonate hardness
= 225 – 225 = 0 mg/l

∴ Non-carbonate hardness is zero.

4. (a)

$$\eta = 100\,(1 - e^{-\lambda d})$$

Here, d is depth in m, λ is constant in m^{-1}

∴ $90 = 100\,(1 - e^{-\lambda \times 0.08})$

⇒ $e^{-0.08\lambda} = 0.1$

⇒ $\lambda = 28.78 \text{ m}^{-1}$

Now, $98 = 100\,(1 - e^{-28.78d})$

⇒ $e^{-28.78d} = 0.02$

⇒ $d = 0.1359$ m
= 13.59 cm

5. (c)

Density before compaction = 110 kg/m^3

Area of landfill site = 1 m^3

Let thickness of waste before compaction = x m

∴ Total weight of waste = $110x$ kg

Total weight of waste after compaction = 400 × 1 × 0.14 = 56 kg

∵ Total weight of waste remains the same

∴ $110x = 56$

⇒ $x = 0.509 \simeq 0.51$ m

6. (c)

Senescent lakes are very old shallow lakes, which ultimately become marshy.
Eutrophic lakes have high level of productivity, because of an abundant supply of algal, nutrients, which makes the lake water highly turbid.

7. (d)

$$\text{SVI} = \frac{V_{ob}\,(\text{m}l/l)}{X_{ob}\,(\text{mg}/l)} = \frac{V_{ob}}{X_{ob}} \times 100\ \text{m}l/\text{g}$$

V_{ob} = Settled volume sludge per liter

$$= \frac{850}{2} = 425\ \text{m}l/l$$

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

$$\text{SVI} = \frac{425}{3000} \times 1000 = 141.667 \simeq 142\ \text{m}l/\text{g}$$

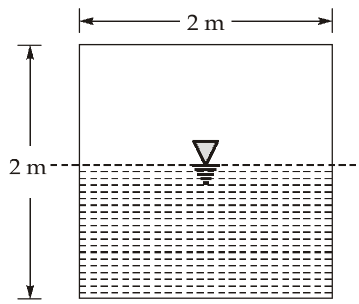
8. (b)

$$\text{Total BOD}_5 \text{ of given sewage} = \frac{10000 \times 10^3 \times 400}{10^6} = 4000\ \text{kg/day}$$

Total BOD_5 is collectively due to domestic sewage and industrial sewage.
Contribution due to industries = 45%
∴ Contribution due to domestic sewage = 100 – 45 = 55%

$$\therefore \text{BOD}_5 \text{ due to domestic sewage} = \frac{4000 \times 55}{100} = 2200\ \text{kg/day}$$

9. (c)



Wetted area, $a = 2 \times 1 = 2\ \text{m}^2$

Wetted perimeter, $p = 2 + 1 + 1 = 4\ \text{m}$

Hydraulic radius, $r = \frac{a}{p} = \frac{2}{4} = 0.5\ \text{m}$

By Manning's equation,

$$q = \frac{1}{n} a r^{2/3} s^{1/2}$$

$$\Rightarrow \quad 1.2 = \frac{1}{0.015} \times 2 \times (0.5)^{2/3} (s)^{1/2}$$

$$\Rightarrow \quad s^{1/2} = \frac{1.20 \times 0.015}{2 \times (0.5)^{2/3}} = 0.0143$$

$$\Rightarrow \quad s = 2.041 \times 10^{-4} = 0.0204\% \simeq 0.02\%$$

10. (b)

Fluoride content upto 1 mg/l can prevent dental cavities.

11. (b)

$FeSO_4 \cdot 7H_2O + Ca(OH)_2 \rightarrow CaSO_4 + Fe(OH)_2 + 7H_2O$

The ferrous hydroxide formed, further oxidised

$4Fe(OH)_2 + O_2 + H_2O \rightarrow 4Fe(OH)_3 \downarrow$

Means 1 mole of copperas makes one mole of $Fe(OH)_2$ and one mole of $Fe(OH)_2$ make one mole of $Fe(OH)_3\downarrow$

∴ Quantity of copperas required to treat 20 million litres of water per day

$$= 20 \times 10^6 \times 9 \times 10^{-6} = 180 \text{ kg/day i.e., } 7.5 \text{ kg/hour}$$

Now, 277.8 gm of copperas finally leads to form 106.8 gm of $Fe(OH)_3$

∴ 7.5 kg/hour of copperas will make $= \frac{106.8}{277.8} \times 7.5 = 2.883$ kg/hour i.e., 2883 gm/hour

12. (c)

A fanning plume occurs in the presence of a negative lapse rate.

13. (d)

Year	Population	(%) r	Δr (%)
1970	56650	-	-
1980	67500	19.15	-
1990	76455	13.26	5.89
2000	85650	12.03	1.23

Average decrease in rate of change of population $= \frac{5.89 + 1.23}{2} = 3.56\%$

$$\% \ r \text{ is } 2010 = 12.03 - 3.56 = 8.47\%$$

$$\% \ r \text{ is } 2020 = 8.47 - 3.56 = 4.91\%$$

$$\text{Population in 2010, } P_{2010} = 85650 + \frac{8.47}{100} \times 85650$$

$$= 92904.56 \approx 92905$$

$$\text{Population in 2020, } P_{2020} = 92905 + \frac{4.91}{100} \times 92905 = 97466.6$$

$$\simeq 97467 \simeq 96000 \text{ (lower multiple of 3000)}$$

14. (a)

$$k = \frac{[HOCl]}{[H^+][OCl^-]}$$

Here concentration is in moles/litre

$$10^{7.4} = \frac{[HOCl]}{[10^{-7.4}][OCl^-]}$$

$$\Rightarrow \quad [HOCl] = [OCl^-]$$

$$\text{Free residual chlorine} = [HOCl] + [OCl^-]$$

$$\Rightarrow \quad \frac{2 \times 10^{-3}}{2 \times 35} = [HOCl^-] + [OCl^-]$$

$\Rightarrow \quad 2.857 \times 10^{-5} = 2[OCl^-]$

$\Rightarrow \quad [OCl^-] = 1.429 \times 10^{-5}$ moles/litre

$\Rightarrow \quad [OCl^-] = 1.429 \times 10^{-5} \times 51 \times 10^3$ mg/l

$\Rightarrow \quad [OCl^-] = 0.729$ mg/l

15. (c)

Relative stability for a sample is given by,

$$s = \frac{O_2 \text{ available in effluent}}{\text{Total } O_2 \text{ required for 1st stage BOD}}$$

Carbonaceous demand (1st stage BOD) = Total oxygen demand – Nitrogenous demand

$= 110 - 60 = 50$ mg/l

$$\therefore \quad s = \frac{40}{50} \times 100 = 80\%$$

16. (b)

General equation of kinetics is

$$\frac{dC_A}{dt} = -kC_A^n$$

Order = 2

$$\therefore \quad \int_{C_o}^{C_t} \frac{dC_A}{C_A^2} = \int_o^t -kdt$$

$$\Rightarrow \quad \left(\frac{1}{C_o} - \frac{1}{C_t}\right) = -kt$$

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

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

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

17. (d)

TS + SS → DS

	Test sample	Seeded sample	Diluted sample
	5 mL	295 mL	300 mL
Initial DO:	5 mg/l	7 mg/L	x
Final DO:	-	-	y

$$x = \frac{5 \times 5 + 7 + 295}{300} = 6.967 \text{ mg}/l$$

Also, $\quad x - y = 6.967$ (after 5 days of incubation)

$\Rightarrow \quad y = 0$ mg/l

$\because$ Final DO of diluted sample is zero.

Hence, the readings should be discarded.

18. (b)

Given: $P = 30000$, $R = 1$

Quantity of domestic sewage produced per day

$$= \frac{30000 \times 130}{1 \times 10^6} = 3.9 \text{ MLD}$$

Total BOD of sewage = 3.9 × 250 = 975 kg/day

Out of this BOD, 36% is already removed in PST.

∴ BOD to be removed in filter = 0.64 × 975 = 624 kg/day

$$\text{Volume of filter media required} = \frac{\text{Total BOD to be removed}}{\text{Organic loading}} = \frac{624}{10000} \times 10^4 = 624 \text{ m}^3$$

$$\text{Recirculation factor,} \quad F = \frac{1+R}{(1+0.1R)^2} = \frac{1+1}{(1+0.1\times 1)^2} = 1.65$$

Efficiency of this filter is given by

$$\eta = \frac{100}{1+0.44\sqrt{\frac{Q_o y_1}{V \times F}}} = \frac{100}{1+0.44\sqrt{\frac{624}{624 \times 1.65}}} = 74.5\%$$

19. (c)

Critical oxygen deficit is given by,

$$\left(\frac{L_o}{D_c f}\right)^{f-1} = f\left[1-(f-1)\frac{D_o}{L_o}\right]$$

$$f = \frac{k_R}{k_D} = \frac{0.05}{0.03} = \frac{5}{3}$$

$$\left(\frac{12}{D_c \times \frac{5}{3}}\right)^{2/3} = \frac{5}{3}\left[1-\frac{2}{3}\times\frac{5}{12}\right]$$

⇒ $D_c = 5.45$ mg/l

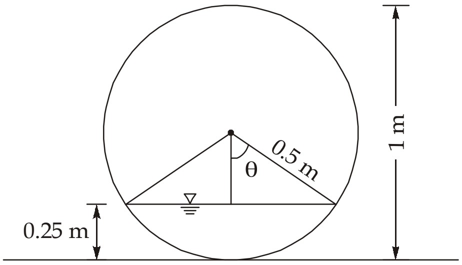
$$D_c = \frac{k_D L_o}{k_R} e^{-k_D t_C}$$

⇒ $$\frac{5.45 \times 0.05}{0.03 \times 12} = e^{-0.03 t_C}$$

⇒ $0.03 t_C = 0.2784$

⇒ $t_C = 9.28$ days

20. (b)



$$\cos\theta = \frac{0.5 - 0.25}{0.5} = \frac{0.25}{0.5} = \frac{1}{2}$$

$$\Rightarrow \quad \theta = \frac{\pi}{3}$$

Cross-sectional area of flow, $A = r^2\left[\theta - \frac{\sin 2\theta}{2}\right]$

$$\Rightarrow \quad A = (0.5^2)\left[\frac{\pi}{3} - \left\{\sin\left(2\times\frac{\pi}{3}\right)\right\}\frac{1}{2}\right]$$

$$\Rightarrow \quad A = \frac{1}{4}\left[\frac{\pi}{3} - \frac{\sqrt{3}}{4}\right]$$

$$A = 0.1535 \text{ m}^2$$

Wetted perimeter of flow $= r\,(2\theta)$

$$= 0.5 \times 2 \times \frac{\pi}{3} = 1.047 \text{ m}$$

$\therefore$ Hydraulic radius $= \frac{A}{P} = \frac{0.1535}{1.047} = 0.147$ m

21. (a)

(i) Lapse rate $= -\frac{dT}{dz} = \frac{T_1 - T_2}{z_2 - z_1}$

$$= \frac{15.2 - 14.8}{70 - 15} = \frac{0.4}{55}\frac{°\text{C}}{\text{m}}$$

$$= \frac{1}{137.5} < \frac{1}{100}$$

ALR > ELR = Stable.

(ii) Lapse rate $= -\frac{dT}{dz} = \frac{T_1 - T_2}{z_2 - z_1}$

$$= \frac{14.8 - 14.4}{120 - 70} = \frac{0.4}{50}$$

$$= \frac{1}{125} < \frac{1}{100}$$

ALR > ELR = Stable.

22. (a)

Dilution factor, $P = \frac{10}{300} = \frac{1}{30}$

$$BOD_5 = \frac{(DO_i - DO_f) - (B_i - B_f)(1-P)}{P}$$

$$= \frac{(6.2) - (1)\left(1 - \frac{1}{30}\right)}{\frac{1}{30}} = 157 \text{ mg}/l$$

23. (d)

Alum reacts with alkalinity and hence decreases the alkalinity.

24. (b)

For optimum decomposition in sanitary landfill method, moisture content of the refuse must be greater than 60%.

25. (a)

Grit chambers are mainly constructed to prevent the accumulation of inorganic particles in sludge digesters.

26. (d)

Sample size (1 m*l*)

No. of positive tubes $= \frac{288}{360} \times 5 = 4$

Sample size (0.1 m*l*)

Number of positive tubes $= \frac{144}{360} \times 5 = 2$

Sample size (0.01 m*l*)

Number of positive tubes $= \frac{72}{360} \times 5 = 1$

Positive combination is 4 - 2 - 1 and negative combination is 1 - 3 - 4.
But dilution of standard used is 10 m*l*, 1 m*l*, 0.1 m*l*.
So, MPN index for negative results = 38 × 10 = 380

27. (c)

Sodium hexa-metaphosphate is added to the influent of rapid sand filter because it keeps calcium carbonate in dissolved state, which will minimize the sand incrustation.

28. **(c)**

$$Cl_2 + H_2O \xrightleftharpoons{pH>3} \underbrace{HOCl}_{\text{Hypochlorous acid}} + H_2O$$

$$HOCl \underset{pH<7}{\overset{pH>8}{\rightleftharpoons}} H^+ + \underbrace{OCl^-}_{\text{Hypochlorite ion}}$$

29. **(b)**

30. **(a)**

■■■■