CLASS TEST

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Environment Engineering

CIVIL ENGINEERING

Date of Test : 24/08/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

3. (c)

As per IS 10500 : 2012, acceptable limit for the given chloramines (as Cl_2) max is 4 mg/l and ther is no relaxation in permissible limit in absence of alternate source.

5. (b)

$$V = Q \times t_D$$
$$= \frac{3 \times 10^6 \times 10^{-3}}{24} \times 4$$
$$= 500 \text{ m}^3$$
$$\text{Height of tank} = V/A = \frac{500}{175} = 2.86 \text{ m}$$

6. (d)

Dissolved solids cannot be removed in rapid sand filter. Helminth eggs, which range in size from about 10 mm to more than 100 mm, can be removed by many commonly used waste water-treatment processes such as sedimentation, filtration and stabilization ponds. However, some helminth eggs are extremely resistant to environmental stresses and may survive usual waste water and sludge disinfection procedure. Chlorine disinfection and mesophilic anaerobic digestion, for example, are not effective at inactivating many helminth eggs.

7. (a)

$$\text{Velocity gradient, } G = \sqrt{\frac{P}{\mu V}}$$
$$700 \times 700 = \frac{P}{10^{-3} \times 4}$$
$$P = 1960 \text{ W}$$

8. (c)

$$S_Y + S_R = n$$
$$S_Y = 30 - 10 = 20\% = 0.2$$
$$S_Y = \frac{\text{Vol. drained}}{\text{Vol. of catchment}}$$
$$\text{Volume drained} = 0.2 \times 30 \times 2$$
$$= 12 \text{ ha.m}$$

9. (b)

The minimum velocity (or self-cleaning velocity) is

given by $$V_s = \sqrt{\frac{8\beta}{f}(G-1)gd_s}$$

$\beta = 0.06$, $f = 0.02$, $G = 2.66$, $g = 9.81$ m/s^2, $d_s = 10^{-3}$ m

$$V_s = \sqrt{\frac{8 \times 0.06}{0.02}(2.66 - 1) \times 9.81 \times 10^{-3}}$$

$$V_s = 0.625 \text{ m/s}$$

10. (c)

$$\text{Sludge volume index SVI} = \frac{V_{ob}(\text{m}l/l)}{X_{ob}(\text{mg}/l)} \times 1000$$

$$= \frac{300}{5000} \times 1000$$

$$= 60 \text{ ml/gm}$$

11. (c)

We know that $y_t = L_o(1 - 10^{-k \times t})$

here, it is given that $y_t = 75\% \ L_o$

$y_t = 0.75 \ L_o$

Hence $0.75 \ L_0 = L_o(1 - 10^{-k \times 4})$

$0.75 = 1 - 10^{-k \times 4}$

$10^{-4k} = 0.25$

Takin Log both sides

$-4k = \log 0.25$

$\Rightarrow$ $k = 0.15$ per day

12. (b)

We know that, $\frac{V_1}{V_2} = \frac{100 - P_2}{100 - P_1}$

$$\frac{V_1}{V_2} = \frac{100 - 92}{100 - 96} = \frac{8}{4}$$

$$V_2 = \frac{V_1}{2}$$

$$\text{Percentage decrease} = \frac{V_1 - V_2}{V_1} \times 100 = \left(1 - \frac{V_2}{V_1}\right) \times 100 = \left(1 - \frac{1}{2}\right) \times 100$$

$$= 50\%$$

13. (c)

In a litre solution

$$[OH^-] = \frac{51 \times 10^{-3}}{17} \frac{\text{mol}}{l}$$

$$[OH^-] = 3 \times 10^{-3} \text{ mol}/l$$

$$pOH = -\text{Log}_{10}(3 \times 10^{-3}) = 2.52$$

$$pH = 14 - 2.52 = 11.48$$

14. (c)

Total solids, $S_T = \frac{0.952}{10^3} \times 10^6 = 952$ ppm

Fixed solids, $S_F = \frac{0.516}{10^3} \times 10^6 = 516$ ppm

Volatile solids, $S_V = S_T - S_F = 952 - 516 = 436$ ppm

16. (b)

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

$$= \frac{300 \times 50 + 8 \times 600}{650}$$

$$= \frac{15000 + 4800}{650} = 30.46 \text{ mg}/l$$

17. (d)

As we know,

$$\frac{1}{\theta_C} = \frac{QY(S_0 - S)}{VX} - k_d$$

$$\frac{1}{10} = \frac{10000 \times 0.5[150 - 5]}{V \times 3000} - 0.05$$

$$V = 1611.11 \text{ m}^3 \simeq 1611 \text{ m}^3$$

18. (c)

$$\text{Required cloth area} = 10 \text{ m}^3/\text{s} \times \frac{60s}{\text{min}} = 600 \text{ m}^3/\text{min}$$

$$= \frac{600 \text{ m}^3/\text{min}}{1.5 \text{ m}/\text{min}} = 400 \text{ m}^2$$

Surface area of one bag $= \pi DH = \pi \times 0.3 \times 5$

$= 4.712 \text{ m}^2$

Total number of bags required $= \frac{400}{4.712} = 84.89 \simeq 85$

19. (c)

$y_2 = 100$ mg/l ; $t_2 = 2$ days

$y_4 = 175$ mg/l ; $t_4 = 4$ days

$k_D = ?$

$$y_2 = y_0\left(1 - e^{-k_D t_2}\right)$$

$$y_4 = y_0\left(1 - e^{-k_D t_4}\right)$$

$$\frac{y_2}{y_4} = \frac{1 - e^{-k_D 2}}{1 - e^{-k_D 4}}$$

$$\frac{100}{175} = \frac{1-e^{-2k_D}}{1-e^{-4k_D}}$$

$$1.75 - 1.75x = 1 - x^2$$

$$x^2 - 1.75x + 0.75 = 0$$

$$x = 1, 0.75$$

when $x = 1$

$$e^{-2k_D} = 1$$

$\Rightarrow$ $k_D = 0$

when, $x = 0.75$

$$e^{-2k_D} = 0.75$$

$$k_D = 0.1438 \text{ day}^{-1}$$

20. **(d)**

Organic matter stabilized per day = $Q\,[S_i - S_0] \times \eta$

$= 400 \times 10^3\,[1800 - 300] \times 0.75$

$= 450$ kg

$\because$ 1 kg BOD generates 0.35 m^3 methane

$\therefore$ 450 kg BOD generates $= 0.35 \times 450 = 157.5\ m^3$

21. **(c)**

$$Q_w = 2.5\ m^3/s,\ y_w = 100\ mg/l$$

$$Q_R = 10\ m^3/s,\ y_R = 5\ mg/l$$

Ultimate BOD of mixture,

$$y_0 = \frac{(2.5\times100+10\times5)}{2.5+10} = 24\ mg/l$$

$$(k_D)_{10} = 0.434\ k = 0.434 \times 0.25 = 0.1085\ \text{day}^{-1}$$

Now, BOD consumed

$$y_t = y_0\,[1 - (10)^{-k_Dt}] \quad \text{...(i)}$$

Area of river = 50 m^2

Flow of river = 10 m^3/s

$$\text{Stream velocity} = \frac{(10+2.5)}{50} = 0.25\ m/sec$$

Time taken to travel 12 km,

$$t = \frac{12\text{ km}}{0.25\text{ m/s}} = \frac{12000}{0.25} = 0.55\text{ days}$$

$\therefore$ From equation (i) $BOD_{left} = y_0 - y_t$

$$= y_0 \times 10^{-k_Dt}$$

$$= 24 \times 10^{-0.1085 \times 0.55}$$

$$= 20.89\ mg/l$$

22. (a)

Net the waste is 10 kg.

Component	mass (kg)	Energy kJ/kg	Total energy, kJ
Paper	65	16750	1088750
Food waste	25	4650	116250
Plastics	5	32600	163000
Tin cans	5	700	3500
			Total = 1371500 kJ

$$\text{Unit energy content} = \frac{1371500}{100} = 13715\frac{\text{kJ}}{\text{kg}}$$

The energy content on an ash-free and dry basis :

$$\text{kJ/kg (ash-free and dry basis)} = 13715 \times \frac{100}{100 - 22 - 5} = 18787.67 \text{ kJ/kg}$$

23. (c)

The maximum flow velocity in sewer occurs when depth of flow, $d = 0.81D$ and is 12.5% more than velocity at full flow condition.

24. (d)

Benfield and Randal derive the equation for extended aeration tank volume as

$$(V)_{EA} = \frac{YQ_0(S_0 - S)}{XK_d}$$

$$= \frac{0.4 \times 30000 \times (300 - 5)}{4000 \times 0.03} = 29500 \text{ m}^3$$

25. (c)

26. (b)

$$\text{BOD}_5 \text{ (at 20°C)} = \frac{(D_1 - D_2) - (B_1 - B_2)(1 - P)}{P}$$

$$= \frac{6.8 - 2.0\left(1 - \frac{20}{300}\right)}{\frac{20}{300}} = 74 \text{ mg}/l$$

27. (c)

The higher values of pH means lower hydrogen ions concentration.

Lower value of pH of water may cause tuberculation and corrosion whereas higher values of pH may cause incrustation of water supply pipes.

28. (d)

Stearic acid oxidation occurs as per following reaction:

$$\underset{284}{C_{17}H_{35}COOH} + \underset{832}{26O_2} \longrightarrow \underset{792}{18CO_2} + \underset{324}{18H_2O}$$

$\therefore$ 1 part of stearic acid on oxidation requires $\frac{832}{284}$ parts of oxygen to produce carbon dioxide and water.

Now quantity of stearic acid = Flow × Concentration

$$= 80 \times 10^3 \times 150 \times 10^{-3}$$
$$= 12000 \text{ gm}$$

$\therefore$ 12000 gm of stearic acid will require $\left(\frac{12000 \times 832}{284}\right)$ gm of oxygen

$$= 35154.93 \text{ gm of oxygen}$$
$$BOD_5 = 0.7 \times \text{Theoretical oxygen demand}$$
$$= 0.7 \times 35154.93\text{g}$$
$$= 24608.450 \text{ g}$$
$$= 24.608 \text{ kg} \simeq 24.61 \text{ kg}$$

29. (c)

$$\text{Amount of chlorine required daily} = \frac{0.75 \times 20000 \times 10^3}{10^6} = 15 \text{ kg}$$

$$\text{Amount of beaching powder required daily} = \frac{15 \times 100}{25} = 60 \text{ kg}$$

30. (b)

Sewage produced = 735000 litres/day

5 day BOD of sewage = 190 mg/litres

BOD of effluent = 28 mg/litres

$\therefore$ BOD removed by pond = (190 – 28) = 162 mg/litres

$\therefore$ Sewage solids removed per day = 735000 × 162 = 119.07 kg

It is given that organic loading rate = 65 kg/ha/day

$$\therefore \text{Area required for pond} = \frac{119.07}{65} = 1.832 \text{ ha} \simeq 1.83 \text{ ha}$$

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