CLASS TEST

Sl. : 04 IG_CE_C+D_140822

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ENVIRONMENT ENGINEERING

CIVIL ENGINEERING

Date of Test : 14/08/2022

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)

$$BOD_5 = (\text{Initial DO} - \text{Final DO}) \times \text{Dilution factor}$$

$$= (9.36 - 6.2) \times \frac{100}{2.5} = 126.4 \text{ mg}/l$$

4. (a)

$$L = \frac{(0.5 \text{ m}^3/\text{s}) \times (86400 \text{ s/d})}{150 \text{ m}^3/\text{day/m}} = 288 \text{ m}$$

5. (b)

$$(100 - P_1)\, V_1 = (100 - P_2)\, V_2$$

$$\Rightarrow \quad \frac{V_2}{V_1} = \frac{100 - P_1}{100 - P_2}$$

$$= \frac{100 - 97}{100 - 95} = \frac{3}{5} = 0.6$$

So, decrease in volume by 40%.

7. (c)

The drop manholes are provided in sewerage system when there is change in elevation of ground level.

10. (c)

$$\text{Sound pressure level (dB)} = 20\log_{10}\left(\frac{P}{P_0}\right)$$

where P is sound pressure in N/m^2

and P_0 is reference pressure (= 2 × 10^{-5} N/m^2 or 20 μPa)

For given sound pressure, P = 3000 μ bar = 300 N/m^2 $\left[\because 1 \text{ bar} = 1 \times 10^5 \text{Pa} = 1 \times 10^5 \text{ N/m}^2\right]$

$$\therefore \quad \text{Sound pressure level} = 20\log_{10}\left(\frac{300}{2 \times 10^{-5}}\right) = 143.52 \text{ dB}$$

11. (d)

Statement-1 : Raw sludge is more objectionable in comparison to secondary sludge because it has more putrescible organic matter.

Statement-3 : Secondary sludge from trickling filter has solid content (2-4)% and activated sludge process has solid content of (1-2)%.

12. (b)

For SO_2

$$\text{Minimum height of chimney} = 14\,(Q_s)^{1/3}\text{ m}$$

$$Q_s = SO_2 \text{ emission in kg/hr}$$

$$Q_s = 0.72 \text{ tonnes/day}$$

$$= 720 \text{ kg/24 hr}$$

$$= 30 \text{ kg/hr}$$

So, $$\text{Height of chimney} = 14\,(30)^{1/3}$$

$$= 43.5 \text{ m}$$

13. (b)

Statement 2 and 3 are the properties of iron salts not alum salts.

15. (d)

Velocity of sand particles,

$$V_s' = \frac{g}{18}(G-1)\cdot\frac{d^2}{\nu}$$

$$\Rightarrow \quad V_s' = \frac{9.81}{18}\times(2.65-1)\times\frac{\left(0.01\times10^{-3}\right)^2}{10^{-3}/1000}$$

$$\Rightarrow \quad V_s' = \frac{9.81}{18}\times1.65\times10^{-4}$$

$$\Rightarrow \quad V_s' = 8.9925\times10^{-5}\text{ m/s}$$

$$\text{Setting time} = \frac{\text{Volume of tank}}{\text{Water flow rate}}$$

$$= \frac{900\times3}{8000}\text{ days} = \frac{2700}{8000}\times24 = 8.1\text{ hours}$$

$$\text{Settling velocity, } V_s = \frac{\text{Depth of tank}}{\text{Settling time}}$$

$$= \frac{3}{8.1\times3600} = 1.0288\times10^{-4}\text{ m/s}$$

$$\therefore \quad \text{Removal efficiency} = \frac{V_s'}{V_s}\times100$$

$$= \frac{8.9925\times10^{-5}}{1.0288\times10^{-4}}\times100 = 87.41\%$$

16. (a)

$$\text{Recirculation factor, } F = \frac{1+R/I}{\left(1+\frac{0.1R}{I}\right)^2} = \frac{1+1.5}{(1+0.1\times1.5)^2} = 1.89$$

$$\text{Efficiency of filter, } \eta = \frac{100}{1+0.0044\sqrt{\frac{Y}{V\times F}}}$$ (where V = 0.12 ha.m)

$$\Rightarrow \quad 80 = \frac{100}{1+0.0044\sqrt{\dfrac{Y}{0.12\times1.89}}}$$

$$\Rightarrow \quad Y = 732.18 \text{ kg/day}$$

17. (c)

Velocity gradient, $$G = \sqrt{\frac{P}{\mu V}}$$

Power input per unit volume, $$P = \mu G^2 V$$
$$= 1 \times 10^{-3} \times (450)^2 \times 4$$
$$= 810 \text{ W}$$

Now, power input per unit volume $$= \frac{P}{V} = \frac{810}{4} = 202.5 \text{ W/m}^3$$

18. (c)

Sound pressure, $$L = 20\log_{10}\left(\frac{P_{rms}}{20\mu Pa}\right)\text{dB}$$

$$L = 20\log_{10}\frac{2000}{20}$$
$$= 20 \log_{10} 100$$
$$= 40 \text{ dB}$$

So, resultant of two sound sources of 40 dB and 40 dB = 43 dB

19. (a)

For Infiltration gallery,

$$Q = kL\left(\frac{H^2-h^2}{2R}\right)$$

where, $Q = 600 \text{ m}^3/\text{day}$

$H = 6$ m, $k = 100$ m/day

$R = 100$ m

$h = 6 - 4 = 2$ m

$$\therefore \quad 600 \text{ m}^3/\text{day} = 100 \text{ m/d} \times L \text{ (in m)} \times \left(\frac{6^2-2^2}{2\times100}\right)\frac{\text{m}^2}{\text{m}}$$

$$\Rightarrow \quad 600 = \left(100\times L\times\frac{32}{200}\right)$$

$$\Rightarrow \quad L = 37.5 \text{ m}$$

21. (b)

Required chlorine dose = Chlorine demand + Residual chlorine

$= 1.28 + 0.22 = 1.5 \text{ mg}/l$

$\therefore$ Total chlorine required per day

$= 1.5 \times 10^{-6} \times 6.4 \times 10^{6} = 9.6 \text{ kg}$

Available chlorine in bleaching powder = 20%

$\therefore$ Bleaching powder required

$$= \frac{9.6}{0.20} = 48 \text{ kg}$$

22. (a)

$N = N_0\, 10^{kt}$ (I[st] order reaction)

$\therefore \quad 10^9 = 10^3\, (10)^{k \times 10}$

$\Rightarrow \quad 10^6 = (10)^{10k}$

$\Rightarrow \quad k = 0.6$

Now, $N = 2N_0$

$\therefore \quad 2 = 10^{0.6t}$

$\Rightarrow \quad t = 0.5 \text{ hr}$

23. (b)

Sewage produced = 400000 l/day

5-day BOD of sewage = 140 mg/l ($\because$ When water is solvent, 1 ppm = 1 mg/l)

BOD of effluent = 15 ppm =15 mg/l

$\therefore$ BOD removed by pond = (140 – 15) = 125 ppm = 125 mg/l

$\therefore$ Sewage produced per day

$= 400000 \times 125$

$= 50 \times 10^6 \text{ mg} = 50 \text{ kg}$

Organic loading rate = 25 kg/ha/day

$$\therefore \quad \text{Required area} = \frac{\text{Sewage produced}}{\text{Organic loading rate}}$$

$$= \frac{50}{25} = 2 \text{ ha}$$

24. (c)

Hardness is due to multivalent cations.

$$\therefore \quad \text{Total hardness} = \left[Mg^{+2}\right]\times\frac{\text{Eq. weight of } CaCO_3}{\text{Eq. weight of } Mg^{2+}} + \left[Ca^{+2}\right]\times\frac{\text{Eq. weight of } CaCO_3}{\text{Eq. weight of } Ca^{2+}}$$

$$+\left[Al^{3+}\right]\times\frac{\text{Eq. weight of } CaCO_3}{\text{Eq. weight of } Al^{3+}}$$

$$= 48\times\frac{50}{12} + 45\times\frac{50}{20} + 5\times\frac{50}{9} = 340.28 \text{ mg}/l \text{ as } CaCO_3$$

25. (a)

Total no. of cigarettes consumed per hour = 50 × 1.3 = 65

Total formaldehyde produced per hour = 65 × 1.3 = 84.5 mg

This 84.5 mg of formaldehyde provide per hour gets mixed with 1300 m^3/hr of fresh air injected into the room.

Hence concentration of formaldehyde in the room air = $\frac{84.5}{1300} = 0.065 \text{ mg/m}^3$

26. (c)

Flow rate, Q_0 = 800 m^3/hr

Influent BOD, S_0 = 125 mg/l

Effluent BOD, S = 10 mg/l

Hydraulic retention time = 7.5 hr = 0.3125 days

Mean-cell residence time, HRT θ_c = 300 hr = $\frac{300}{24}$ days = 12.5 days

MLSS (X) = 3000 mg/l

Volume = 500 m^3

Food $(F) = QS_0$

$$= \left(800\frac{m^3}{hr}\right)\left(125\frac{mg}{l}\right) = 2400 \text{ kg/day}$$

Biomass $(M) = VX$

$$= \left(500 \text{ m}^3\right)\left(3000\frac{mg}{l}\right)$$

= 1500 kg

$$\therefore \quad \frac{F}{M} = \frac{Q_0S_0}{VX} = \frac{2400}{1500}$$

= 1.6 kg BOD day/kg MLSS

27. (c)

From place A to B,

$$\text{Ambient lapse rate} = \frac{21-18.5}{350-45}\times 1000 = 8.197 < 9.8°\text{C/km}$$

Since lapse rate is less than the adiabatic lapse rate, so ambient lapse rare is said to be subadiabatic.

From B to C,

$$\text{Ambient lapse rate} = \frac{18.5-14}{500-350}\times 1000 = 30°\text{C/km} > 9.8°\text{C/km}$$

So lapse rate is superadiabatic.

28. (c)

$$\text{Solid content} = 3.5\%$$

$$\therefore \quad \text{Water content} = 100 - 3.5 = 96.5\%$$

$$\frac{100}{S_{sludge}} = \frac{96.5}{1} + \frac{3.5}{2.4}$$

$$\Rightarrow \quad S_{sludge} = 1.02084$$

$$\therefore \quad \rho_{sludge} = 1.02084 \times 1000$$

$$= 1020.84 \text{ kg/m}^3$$

After sludge gets thickened,

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

$$\therefore \quad V_2 = \frac{(100-P_1)}{(100-P_2)}\times V_1$$

$$\Rightarrow \quad \frac{V_1}{2} = \frac{(100-96.5)}{(100-P_2)}\times V_1$$

$$\Rightarrow \quad 100 - P_2 = 200 - 193.0$$

$$\Rightarrow \quad 100 - P_2 = 7$$

$$\Rightarrow \quad P_2 = 93\%$$

$$\therefore \quad \text{Solid content} = 100 - 93 = 7\%$$

30. (d)

The field capacity of munipal solid waste is the total moisture that can be retained in a waste sample against gravity.

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