CLASS TEST

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Environment Engineering

CIVIL ENGINEERING

Date of Test : 03/10/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (d)

2. (c)

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

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

3. (a)

4. (b)

5. (b)

The presence of nitrogen in sewage indicates the presence of organic matter and may occur in the form of free ammonia, albuminoid nitrogen, nitrites and nitrates. The free ammonia indicates the very first stage of decomposition of organic matter (thrust indicating recently staled sewage); albuminoid nitrogen indicates quantity of nitrogen present in sewage before the decomposition of organic matter is started; the nitrites indicate the presence of partly decomposed (not fully oxidized) organic matter; and nitrates indicate the presence of fully oxidized matter.

6. (c)

$$\text{Daily BOD contributed by waste} = 162 \times \frac{1000 \times 1000}{10^3} = 162{,}000 \text{ g/day}$$

$$\text{Population equivalent} = \frac{162{,}000}{80} = 2025$$

7. (a)

$$\text{Relative stability,} \quad S = 100\left[1 - (0.794)^{t(20)}\right]$$

$$= 100\,[1 - (0.794)^{12}] = 93.72\%$$

8. (c)

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

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

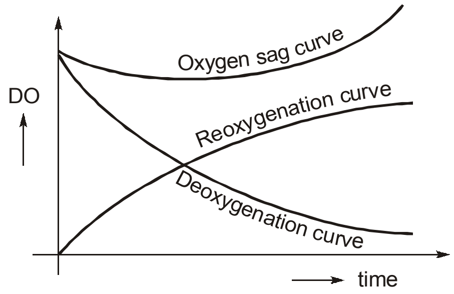
$$= \frac{100 - 97}{100 - 95} = \frac{3}{5} = 0.6$$

So, decrease in volume by 40%.

9. (b)

$$\text{SVI} = \frac{250}{3200} \times 1000 = 78.125 \text{ m}l/\text{g} \simeq 78.13 \text{ m}l/\text{g}$$

10. (a)



11. (a)

Sewage produced = 400000 l/day

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

BOD of effluent = 15 ppm = 15 mg/l

∴ BOD removed by pond = (140 – 15) = 125 ppm = 125 mg/l

∴ Sewage produced per day

$= 400000 \times 125$

$= 50 \times 10^6$ mg = 50 kg

Organic loading rate = 25 kg/ha/day

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

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

12. (a)

Stoke's law states that denser and larger particles have a higher settling velocity, thus a higher overflow rate. Hence size and density of particle affects the overflow rate.

When the temperature decreases, the rate of settling becomes slower. When the water is colder, the flow in the plant is at its lowest and the detention time in the plant is increased so the floc has time to settle out in the sedimentation basins.

13. (a)

$$\text{Ambient lapse rate} = \frac{21.25 - 15.70}{(444 - 4)} \times 1000$$

$= 12.6$ °C/km > 9.8°C/km

When the ambient lapse rate exceeds the adiabatic lapse rate, the ambient lapse rate is said to be super adiabatic.

14. (a)

Velocity gradient (G) = 600 s^{-1}

Volume of mixer (V) = 2.0 m^3

Absolute viscosity of fluid (μ) = 1×10^{-3} N-s/m^2

We know, $P = G^2 \mu V$

$$\therefore \quad \text{Power input per unit volume} \left(\frac{P}{V}\right) = \mu G^2$$

$= 10^{-3} \times (600)^2 = 360$ W

15. (a)

In this disinfection process, we have the relationship,

$$tC^n = k$$

where, t = time required to kill all pathogenic organisms

C = concentration of disinfectant

n = dilution coefficient

k = constant

$$\therefore \quad t_1C_1^n = t_2C_2^n \quad \text{...(i)}$$

In our case, $n = 1$

$$t = \frac{L}{V}$$

L = length of pipe, V = velocity of flow

$$\therefore \quad t = \frac{L}{Q/A} = \frac{L \times A}{Q}$$

$$C = \frac{W}{Q}$$

where, W = weight of disinfectant per day

Q = discharge per day

Substituting C and t in equation (i),

$$\frac{L \times A}{Q_1} \times \frac{W_1}{Q_1} = \frac{L \times A}{Q_2} \times \frac{W_2}{Q_2}$$

$$\Rightarrow \quad W_2 = \frac{Q_2^2}{Q_1^2} \times W_1 = \left(\frac{28}{22}\right)^2 \times 40 \text{ kg/d} = 64.79 \text{ kg/day}$$

16. (a)

17. (c)

18. (b)

19. (b)

$$\text{Weight of alum required per day} = \frac{15 \times 10^6 \times 18}{10^6} = 270 \text{ kg}$$

The chemical reaction is

$$Al_2(SO_4)_3.18\,H_2O + 3Ca(HCO_3)_2 \rightarrow 2Al(OH)_3 + 3CaSO_4 + 6CO_2 + 18H_2O$$

Molecular weight of $Al_2(SO_4)_3.18\,H_2O$ = 666 mg

Molecular weight of CO_2 = 44

From chemical reaction, it is evident that 666 mg of alum releases $6 \times 44 = 264$ mg of CO_2

$$\therefore \quad \text{270 kg of alum will release } CO_2 = \frac{264}{666} \times 270 = 107 \text{ kg}$$

20. (a)

BOD remaining after 10 days

$$= BOD_u \times e^{-Kt}$$
$$= 28 \times e^{-0.16 \times 10}$$
$$= 5.653 \text{ mg}/l$$

$\therefore$ Percent BOD remaining $= \dfrac{5.653}{28} \times 100 = 20.2\%$

$\therefore$ BOD exerted in 10 days $= (100 - 20.2) = 79.8\%$

21. (b)

$$\text{Waste generated} = \frac{150000}{3.5} \times \frac{25}{10^3} = 1071 \text{ tonnes/week}$$
$$= 55700 \text{ tonnes/year}$$

Volume of landfill space required

$$= \frac{55700 \times 10^3}{500} = 111 \times 10^3 \text{ m}^3\text{/year}$$

$$\text{Required land area} = \frac{111 \times 10^3}{10} = 11100 \text{ m}^2$$
$$= 1.11 \text{ ha/year}$$

So, total area required for landfill for 20 years = 1.11 × 20 = 22.2 ha

22. (c)

$$Q = \frac{2\pi T(s_1 - s_2)}{l n\left(\dfrac{r_2}{r_1}\right)}$$

$$T = \frac{55 \times 10^{-3} \times 24 \times 60 \times 60 \times \ln\left(\dfrac{120}{12}\right)}{2 \times \pi \times (3.5 - 0.75)}$$
$$= 633.25 \text{ m}^2\text{/day}$$

23. (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.

$\therefore$ $$Q_{s,\text{(peak)}} = 3 \times Q_{DWF}$$
$$= 3\,(50{,}000 \times 135 \times 0.75) = 15187500 \text{ lit/day}$$
$$= \frac{15187500 \times 10^{-3}}{86400} = 0.175 \text{ m}^3\text{/sec}$$

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

$$Q_{\text{runoff(paek)}} = \frac{1}{36} P_c\, k.A$$
$$A \text{ (in ha)} = 80 \text{ ha}$$
$$P_c \text{ (in cm/hr)} = 1.6 \text{ cm/hr}$$

$$k = 0.7$$

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

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

24. (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, $R = \frac{D}{4}$ (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)

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

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

25. (a)

Molecular weight of glumatic acid = $5\times 12 + 9\times 1 + 4\times 16 + 14 = 147$ gm

Total oxygen used in the reaction = $6.5\times 32 = 208$ gm

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

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

26. (a)

$$\text{Total average demand} = 50{,}000 \times 180 = 9 \times 10^6\ l/\text{day}$$

$$q = 9\text{ MLD}$$

$$\therefore \quad \text{Maximum daily demand} = 1.8q = 1.8 \times 9 = 16.2\text{ MLD}$$

$$(Q)\ \text{Rate of filtration, } f_r = 150\text{ lit/hr/m}^2$$

$$\therefore \quad \text{Total area of filters, } A = \frac{Q}{f_r} = \frac{16.2 \times \dfrac{10^6}{24}\text{ lit/hr}}{150\text{ lit/hr/m}^2} = 4500\text{ m}^2$$

$$\text{Area of each filter unit} = 750\text{ m}^2$$

$$\therefore \quad \text{No. of working units required} = \frac{4500}{750} = 6$$

∴ Total no. of filter units required keeping one unit as stand by = 6 + 1 = 7

27. (a)

Given,

$$(\text{BOD})_{5\text{day}} = 150\text{ mg}/l \text{ at } 20°\text{C}$$

$$k(\text{base } 10) = 0.2\text{ d}^{-1}$$

$$\text{To find } (\text{BOD})_{8\text{day}} = ?\text{ at } 15°\text{C}$$

$$\text{Temperature coefficient} = 1.145$$

$$Y_5 = l_0(1 - 10^{-K_D t})$$

$$50 = l_0(1 - 10^{-0.2\times5})$$

$$l_0 = \frac{150}{1-10^{-1}} = 166.67\text{ mg/lit}$$

$$K_{D(T=15°\text{C})} = K_{D(T=20°\text{C})}(1.145)^{T-20}$$

$$= 0.2(1.145)^{15-20} = 0.1016\text{ d}^{-1}$$

8 day BOD

$$\therefore \quad Y_8 = l_0(1 - 10^{-K_D\times8})$$

$$= 166.67(1 - 10^{-0.1016\times8}) = 141.03\text{ mg/lit}$$

28. (b)

$$\text{Intensity level} = 10\log\left(\frac{I}{I_0}\right)$$

In first source, $\dfrac{I}{I_0} = 4$

$$\therefore \quad \text{Thus increased intensity level} = 10\log\left(\frac{I}{I_0}\right) = 10\log(4) = 6\text{dB}$$

and in second source, $\dfrac{I}{I_0} = 8$

$$\therefore \quad \text{Thus increased intensity level} = 10\log\left(\frac{I}{I_0}\right) = 10\log(8) = 9\text{dB}$$

29. (c)

Global Warming : As the concentration of CO_2 keeps increasing, more and more heat will be built up in the atmosphere and on Earth's surface. Thus, the atmospheric temperature will increase due to the effect of green house.

Acid Rain : Acid rain results when gaseous emissions of sulphur oxides (SO_x) and nitrogen oxides (NO_x) interact with water vapour and sunlight and are chemically converted to strong acidic compound (H_2SO_4 and HNO_3).

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