CLASS TEST

Sl.: 01 IG_CE_B+D_17042023

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ENVIRONMENT ENGINEERING

CIVIL ENGINEERING

Date of Test : 17/04/2023

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)

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

$= \sqrt{\dfrac{1.2\times10^3}{1.29\times10^{-3}\times30\times12\times5}}$ $(\because 1\text{ kg/m.sec} = 1\text{ Ns/m}^2)$

$= 22.733\text{ sec}^{-1}$

2. (c)

Head loss $= h(1 - n)(G - 1)$ [G = Specific gravity = 2.5]

$= 0.6\ (1 - 0.5)\ (2.5 - 1)$

$= 0.45$ m

3. (b)

$$Q = \frac{2\pi KDS}{2.303\log_{10}\left(\dfrac{R}{r_w}\right)}$$

$$\Rightarrow \quad 0.03 = \frac{2\pi K \times 27 \times 3}{2.303\log_{10}\left(\dfrac{200}{0.08}\right)}$$

$K = 4.613 \times 10^{-4}$ m/sec

$= 39.856$ m/day

4. (c)

Anaerobic bacteria in Bangalore method use Carbon 30 to 50 times faster than Nitrogen.

5. (a)

$$\text{Population equivalent} = \frac{\text{Total SS per day in industrial waste}}{\text{Std SS of domestic sewage per person per day}}$$

$$= \frac{90000\times100}{50\times1000} = 180$$

6. (b)

$$\text{Surface loading rate} = \frac{720}{12\times1.5} = 40\text{ m}^3/\text{hr/m}^2$$

$$\text{Detention time} = \frac{V}{Q} = \frac{12\times1.5\times0.8}{720}\times60 = 1.2\text{ minutes}$$

7. (c)

$$\text{Amount of chlorine required daily} = \frac{0.75\times20000\times10^3}{10^6} = 15\text{ kg}$$

$$\text{Amount of beaching powder required daily} = \frac{15\times100}{25} = 60\text{ kg}$$

8. (c)

$$\text{Volumetric loading rate, } U = \frac{Q \times y_i}{V}$$

$$\text{where, } V = \text{Capacity of aeration tank} = \frac{Q \times y_i}{(F/M)x_i}$$

So, $U = (F/M)x_i = 0.3 \times 3000 = 900$ mg/day/lt.

$= 0.9$ kg/day/m^3

9. (a)

For SO_2 emission,

Minimum chimney height, $h = 14\,(Q_s)^{1/3}$ (where, Q_s is in kg/hr)

$Q_s = 60$ t/years

$$= \frac{60 \times 10^3}{365 \times 24} = 6.85 \text{ kg/hr}$$

$\therefore$ $h = 14\,(6.85)^{1/3}$

$= 26.59$ m

10. (b)

Check valve of reflux valve or non-returning valve:

- These allow the water to flow in one direction only.
- These are made of brass or gun metal.

Butterfly valve:

- Butterfly valve are used to regulate and stop the flow especially in large size conduits.
- Butterfly valve involve slightly higher head loss than sluice valves and also are not suitable for continuous throttling.

11. (c)

(i) Average daily draft $= \dfrac{(250 \times 64000)}{10^6} = 16$ MLD

(ii) Maximum daily draft = 1.8 times of annual average daily draft = 1.8 × 16 = 28.8 Mld

(iii) Fire demand: $Q = 4637\sqrt{P}\left(1 - 0.01\sqrt{P}\right)$ lit./min (where, P = Population in thousand)

$$Q = 4637\sqrt{64}\left[1 - 0.01\sqrt{64}\right]$$

$= 34128.32$ litres/minute

$$= \frac{34128.32 \times 60 \times 24}{10^6} \text{MLD} = 49.14 \text{ MLD}$$

Coincident draft: D

The maximum of sum of daily demand and the fire demand and the maximum hourly demand is known as the coincident draft.

Hence, Coincident draft = Maximum daily demand + Fire demand, or 2.7 × 16 = 43.2

= 28.8 + 49.14

So, coincident draft = 77.94 MLD

12. (b)

$$\frac{F}{M} = \frac{\text{Amount of BOD}_5}{\text{Amount of VSS}}$$

$$= \frac{252 \text{ mg}/l \times 7.5 l}{1880 \text{ mg}/l \times 1.5\, l} = \frac{1890}{2820}$$

$$= 0.67$$

13. (d)

For the theoretical oxygen demand and the organic carbon concentration [i.e. Total Organic Carbon (TOC)], consider the following oxidation reactions:

$$\underset{(180)}{C_6H_{12}O_6} + \underset{(192)}{6O_2} \longrightarrow 6CO_2 + 6H_2O$$

$$\underset{(78)}{C_6H_6} + \underset{(240)}{7.5O_2} \longrightarrow 6CO_2 + 3H_2O$$

Hence, theoretical oxygen demand is,

$$\text{ThoD} = \frac{192}{180} \times 240 + \frac{240}{78} \times 25 = 332.92 \text{ mg}/l \simeq 333 \text{ mg}/l$$

And, total organic carbon is

$$\text{TOC} = \frac{72}{180} \times 240 + \frac{72}{78} \times 25$$

$$= 119.07 \text{ mg}/l \simeq 119 \text{ mg}/l$$

14. (a)

Solids removed in the units of trickling filter

= 50% of influent suspended solids

$= 0.5 \times 250 = 125 \text{ mg}/l$

$= 125 \times 10^{-3} \text{ kg/m}^3$

Solids removed per day $= 125 \times 10^{-3} \times 1200 = 150$ kg

BOD_5 removed in primary clarification = 20%

∴ BOD applied to filter = 80%

∴ Total BOD applied $= 0.8 \times \frac{220 \times 10^{-6}}{10^{-3}} \times 1200 = 211.2$ kg/d

Solids production @ 0.5 kg/kg of applied BOD

$= 0.5 \times 211.2$ kg/d $= 105.6$ kg/d

∴ Total solids production $= 150 + 105.6 = 255.6$ kg/d

15. (a)

$$V = \frac{Q}{A} = \frac{3.8}{\frac{\pi}{4}\times 2.2^2} = 0.999 \text{ m/sec}$$

$$V = 0.85\, C_H R^{0.63} S^{0.54}$$

$$\Rightarrow \quad 0.999 = 0.85\times 130\times\left(\frac{2.2}{4}\right)^{0.63} S^{0.54} \qquad \left(\because R = \frac{\text{dia.}}{4}\right)$$

$$\Rightarrow \quad S = 3.297\times 10^{-4}$$

$$\Rightarrow \quad S = \frac{1}{3033}$$

16. (a)

Cations	Anions
$Ca^{2+} = \frac{80}{20} = 4$ meq/lt	$HCO_3^- = \frac{152.5}{61} = 2.5$ meq/lt
$Mg^{2+} = \frac{12}{12} = 1$ meq/lt	$SO_4^{2-} = \frac{216}{48} = 4.5$ meq/lt
$Na^+ = \frac{46}{23} = 2$ meq/lt	
Total cations= 7 meq/lt	Total anions = 7 meq/lt

17. (a)

Efficiency of standard rate trickling filter as given by National Research Council (NRC) formula:

$$\eta = \frac{100}{1+0.0044\sqrt{u}} \qquad u = \text{organic loading rate in kg/hac-m/day}$$

$$u = 160 \text{ gm/m}^3\text{/day}$$

$$= \frac{160\times 10^4}{10^3} \text{kg/hac-m/day}$$

$$= 1600 \text{ kg/hac-m/day}$$

$$\therefore \quad \eta = \frac{100}{1+0.0044\sqrt{1600}} = 85.034\% \simeq 85.03\%$$

18. (c)

19. (d)

DO of diluted sample at $t = 0$

$$= \frac{4\times 0.5 + 96\times 4}{100} = 3.86 \text{ mg/lt}$$

$$BOD_5 = (3.86-0.8)\times\frac{100}{4} = 76.5 \text{ mg/lt}$$

$$L_0 = \frac{L_t}{1-10^{-k_D t}} = \frac{76.5}{1-10^{-0.12\times 5}} = 102.16 \text{ mg/lt}$$

20. (c)

Discharge in full flow condition, $$Q = A \times \frac{1}{n} R^{2/3} S^{1/2}$$

$$\Rightarrow \quad Q = \frac{\pi}{4} \times 1.2^2 \times \frac{1}{0.012} \times \left(\frac{1.2}{4}\right)^{2/3} \sqrt{\frac{1}{400}} = 2.112 \text{ m}^3/\text{sec}$$

For half full condition, $Q' = \frac{Q}{2} = \frac{2.112}{2} = 1.056 \text{ m}^3/\text{sec}$

21. (a)

$$\text{SVI} = \frac{\text{Volume of sludge settled}}{\text{MLSS concentration}}$$

$$\Rightarrow \quad \text{SVI} = \frac{200}{2.5} = 80 \text{ m}l/\text{gm}$$

$$\therefore \quad \text{Sludge density index} = \frac{1}{\text{SVI}} = \frac{1}{80} = 0.0125 \text{ gm/m}l$$

22. (c)

23. (a)

Component	Percent by mass	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 :

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

24. (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

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

25. **(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.

26. **(b)**

In sludge digestion process gases like CH_4 (65 to 70%), CO_2 (30%) and traces of other gases is inert gases like hydrogen sulphide etc. are evolved.

27. **(c)**

$$y_2 = 100 \text{ mg}/l\,; \qquad t_2 = 2 \text{ days}$$

$$y_4 = 175 \text{ mg}/l\,; \qquad t_4 = 4 \text{ days}$$

$$k_D = ?$$

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

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

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

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

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

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

$$x = 1,\ 0.75$$

when $\quad x = 1$

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

$\Rightarrow \quad k_D = 0$

when, $\quad x = 0.75$

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

$$k_D = 0.144 \text{ day}^{-1}$$

28. **(d)**

29. **(c)**

The BOD test is conducted for 5 days, at 20°C because after 5 days the nitrogeneous oxygen demand starts.

30. **(a)**

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